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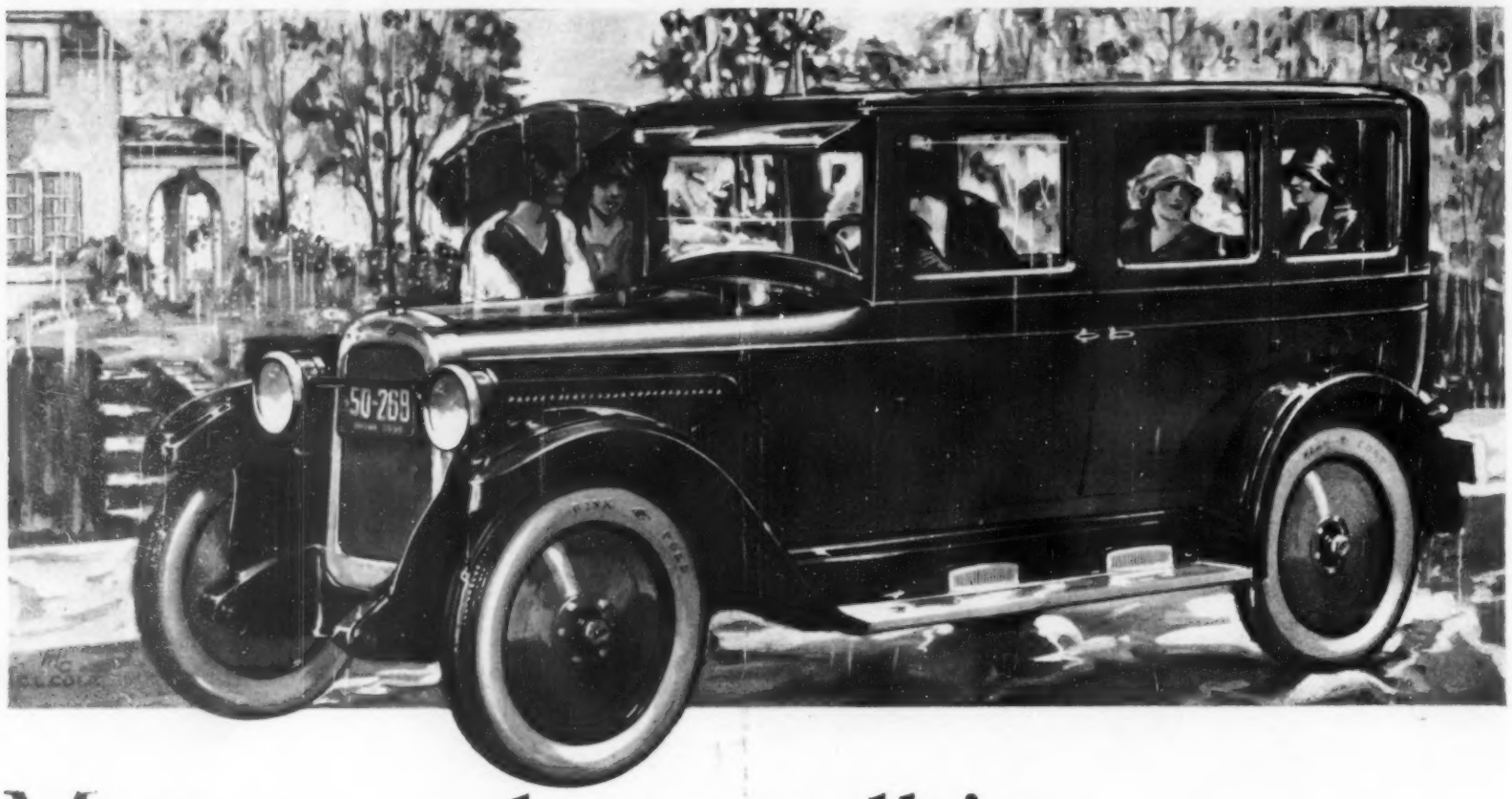

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In an isolated region, almost inaccessible in winter, this automatic hydro-electric plant of the New England Power Company on the Deerfield River starts and stops itself.

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Each Saturday afternoon, the demand for electric current diminishes. Immediately this plant, at the head of the stream, shuts down, and a storage reservoir begins to fill with water. On Monday morning, the plant starts itself and sends water down to all the others.

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TALK

IT is one of the jobs of the Scientific American, as we conceive it, to help start and stop discussion. In this issue we do both. The article on Muscle Shoals will clear up, we hope, some of the points about this project which have been uncertain in the public mind—and therefore, too much discussed, both by persons who prefer a kindly screen of fog and by the plain people who really want to know.

Our discussion-starter for this month is the suggestion which Mr. Slauson makes about how to regulate automobile traffic. We have shown this article in advance to several experienced motorists. They differ among themselves. Doubtless our readers will differ too. Out of such difference and discussion an agreement may emerge.

INVENTION

WHILE we are on the matter of Mr. Slauson's "Short-stop" plan, the chief objection urged by the motorists who do object is the possible uncertainty of marking the point where the car was when signalled to stop. This will depend on the word of the signalling police officer—possibly a good enough way, but one which some motorists regard as dangerous.

We do not believe that this is really a very serious objection. It ought to be possible to devise some way of marking this spot unmistakably at the time when the signal is given. One idea is a toy pistol which, fired toward the ground, would make a spot of soot on the pavement and at the same time sound the stopping signal.

LIGHTS

STILL on the matter of auto traffic, another idea has been suggested by one of the Scientific American staff. This is a signal plate, firmly attached to the car, and bearing three or four differently colored lights. These would be attached to the speedometer, so that the white light, for example, would burn when the speed was ten to fifteen miles an hour, the blue light at from fifteen to thirty, the red at forty, and so on.

If, then, any officer or citizen saw a car running on a city street and burning a red light, that would be sufficient evidence that the speed limit was being exceeded to a dangerous extent.

Maybe that is a good idea too. Something has to be done to make our streets safer for democracy and aristocracy alike.

TOURISTS

HUMAN nature is a pretty constant thing. Archeologists digging in the ruins at Sakkara have found some columns which were once part of an Egyptian temple. This temple was very ancient. Over 3,000 years ago it was already a show place, a sort of Washington Monument of the time.

And on the columns which the archeologists have found are scribbled names and comments, written there by visitors of thirty centuries ago, just as people write their names and addresses on the walls of public buildings today.

In This Issue

A New Plan for Auto Laws

In this issue the Scientific American makes another important contribution to the study of automobile traffic regulation. Mr. Slauson suggests an altogether new idea—the legal use of a stopping limit instead of a speed limit. See page 296.

Who Should Have Muscle Shoals?

It ought to be used for power purposes, says our special investigator, Mr. Alfred P. Lane. And the logical thing to do is to tie it in to the other southern power systems. Making fertilizers there is probably impossible. Page 293.

Are There Other Inhabited Worlds?

Astronomers used to think not. The earth is supposed to have been pulled out of the sun by a passing star. There was small chance, scientists believed, for this to have happened to many stars. But new evidence indicates many planets near other stars. Perhaps they are inhabited. Page 315.

The Baby Man-Ape of Africa

Newspaper readers are already familiar with the recent discovery in South Africa of what is perhaps the most important "missing link" ever found between man and the apes. A full description will be found on page 308.

The Truth About Our Navy

Were we cheated at the Naval disarmament conference? Is it true that our fleet is weaker than that of England—weaker than demanded for our national security? Such charges are made frequently. Mr. Walker says they are untrue. He tells just why on page 306.

MORE THAN ONE HUNDRED PICTURES

Complete table of contents will be found on page 360

For Next Month

Fun During Your Vacation

No man has so much vacation fun as does the scientist. The rocks, the streams, the trees, the plants of the field, the wild animals and birds—all of these things give the scientist something to enjoy. In the June issue Mr. Ingalls will tell you how to make geology help your vacation. Out May 20th.

The Science of Boats

New devices, significant scientific discoveries, novel inventions, are revolutionizing the ancient art of rowing boats. More vacation facts, useful as well as interesting. Mr. Walker, of our staff, will report on these things in our next issue.

When Romans Ruled the World

England, in those days, was an outlying colony of the great empire, as the Philippines are now an outpost of ours. Archeologists in England have been digging up and reconstructing the remains of those far off days. Some remarkable photographs will be in the June issue, out May 20th.

Other articles on Clouds and Weather, on a New Design for Airplanes, on London Fog, on Curious Habits of Spiders, on Discoveries in Ancient Babylonia, on Astronomy.

MORE THAN ONE HUNDRED PICTURES

¶ ***When you plan your vacation you will want to know what Mr. Ingalls has to say about getting fun out of the rocks.***

Our special rate for the next three issues is only one dollar. May we hear from you?

HOOVER

A RECENT newspaper announcement carries the news that the Patent Office of the United States Government has been separated from its long attachment to the Department of the Interior and becomes one of the divisions of the Department of Commerce, the Department headed so ably by Mr. Herbert Hoover.

It is unquestionable that there are strong natural affiliations between Mr. Hoover's Department and the duty of regulating patent and trademark protection. Mr. Hoover possesses, also, an unquestioned administrative ability. On the other hand there are bound to be dislocations and readjustments when so old an association is disturbed.

It is really too soon to say anything about the change. We will have more news about it in next month's issue.

WONDERS

THE star called Mira—which means Wonderful—has recently been measured by the powerful telescopes and delicate instruments at the Mount Wilson Observatory, in California. It turns out to be of the giant class, a star many millions of miles in diameter. Probably it is a great bubble of thin but glowing gas.

This is wonderful enough but the fact that the size of the star has been measured at all is more wonderful still. If anyone had told an astronomer of ancient Greece that we would one day weigh and measure the stars he would have been set down as a madman.

ENERGY

THERE is a still more wonderful thing about this star Mira. It is a variable star. For a while its light is relatively strong. Then the light grows weaker. After a time it comes back again to its original strength. This cycle is repeated over and over again.

There is some reason for believing that these variations are due to an actual pulsation of the star. The great gas bubble may swell out at times until its diameter increases by millions of miles. Then it contracts. Think of a soap bubble attached to a pipe on which the blower alternately blows and sucks.

If anything of this sort is going on in Mira, the amount of energy involved must be terrific. Dr. Russell discusses some of these matters in his article in this issue. He will discuss the new Mira measurements in the next issue.

TIME

ONE idea suggested by a glance at Professor Hoefert's figures of how a man spends his time (which we print on page 305 of this issue) is that so much time seems to be wasted. The amount used up in things like eating and dressing and going to the office and being ill is really a staggering total.

But is this time really wasted? The part of man's activity which counts most, both for himself and for his community, is not the working time of his body. It is the working time of his mind. Ideas may come at any instant.

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EIGHTY-FIRST YEAR

SCIENTIFIC AMERICAN

THE MONTHLY JOURNAL OF PRACTICAL INFORMATION

NEW YORK, MAY, 1925

Muscle Shoals—Bonanza or White Elephant?

By Alfred P. Lane
of the Scientific American Staff

JOHN SMITH and numerous of his fellow citizens are thoroughly disgusted. They have invested their hard-earned dollars in townsites or other property somewhere in the general vicinity of Muscle Shoals, Alabama. They do not see those dollars coming back.

Likewise, thousands of farmers are possessed of the same feeling. The prospect of cheap fertilizer for everybody seems as far away as ever. And all because Congress has adjourned with the problem of what to do with Muscle Shoals apparently as far from solution as it ever was.

"Congress is made up of a bunch of dumb-bells," says Smith to himself gloomily. The farmer echoes, "the Fertilizer Trust is to blame!"

Future historians may find that there are grains of truth in each of these assertions, but the members of our supreme legislative body are certainly not to blame for the utterly extravagant claims which real estate promoters and others have made for Muscle Shoals. Nor is it their fault that neither science nor our transportation system is yet able to guarantee farm fertilizer at half the present prices.

Muscle Shoals No New Idea

In spite of the vast amount of publicity which was given to the Muscle Shoals proposition following Henry Ford's offer to buy it, the average man's knowledge of the subject is limited to a vague idea that Muscle Shoals is some place down south where enormous quantities of fertilizer will some day be made to the everlasting benefit of the farmers of this country. This conception of the situation *may* prove to be true. But what the future has in store, only the future can tell. In the meantime it may be well to see just what we have at Muscle Shoals which might warrant visions of any kind.

The utilization of Muscle Shoals is no new idea. For over a hundred years the advantages of improving navigation on the Tennessee River have been agitated by various associations in the south. One of the worst places in the river, so far as navigation is concerned, is at Muscle Shoals, a point on the river in the northwestern corner of Alabama. Over ninety years ago the State of Alabama constructed a canal around these shoals but it was used for only a short time.

After we got into the war, the question of a supply of nitrates (one form of fixed nitrogen) to be used in the production of explosives became a vital issue. The Government looked about for a suitable spot on which to build a plant for the production of this fixed nitrogen from the air. The government engineers decided that Muscle Shoals had possibilities and negotiations were entered into with the Alabama Power Company. This company sold the land where the Wilson Dam now is to the Government for the sum of one dollar—a patriotic act for which its officers seem to have received but little credit.

Cheap Fertilizer Not Probable

It has been claimed that the power and chemical development at Muscle Shoals will provide cheap fertilizer for a large proportion of southern farms.

It is claimed, also, that Muscle Shoals is a necessary war resource and that it will produce vast amounts of electric power which the government can sell at a profit.

Are these claims true?

The Scientific American wished to find out. We wished, also, to help the country make up its mind what to do with this great war-time project. Congress will be debating this problem at the next session.

We asked Mr. Lane to investigate. This article contains his results. There is small probability, he thinks, of cheap fertilizer.

Possibly some of Mr. Lane's conclusions may surprise you. You will find them in the last few paragraphs of the article.

Here, at last, is an unbiased, competent, utterly disinterested report on the truth about Muscle Shoals.

The entire Muscle Shoals project includes three dams on the Tennessee River. The great Wilson Dam is known officially as Dam Number 2. Dam Number 1 is below Wilson Dam and its function is simply to make navigation possible up to Dam Number 2. The latter will also have locks for navigation purposes and, when completed some time this year, it will be equipped with sufficient machinery to turn out 260,000 horsepower in electric current at those seasons of the year when there is enough water. Its design allows for the installation of additional units up to a total of 610,000 horsepower.

Dam Number 3 is to be located about fifteen miles above Wilson Dam. It will cost approximately half as much as the latter and will develop about forty percent of the power. No work has been done yet on either Dam Number 1 or Dam Number 3, so that, as far as navigation is concerned, no advantages are yet apparent.

Before starting, in 1918, on the construction of the large nitrate plant known officially as Nitrate Plant Number 2 near Muscle Shoals, the Government had already built Nitrate Plant Number 1, about five miles away together with a 5,000 kilowatt steam-driven electric power plant. Shortly after Nitrate Plant Number 2 was under way, the Government began construction work on the Wilson Dam. There being insufficient power available for the construction work, an agreement was entered into with the Alabama Power Company to supply power from their steam plant at Gorgas, Alabama, on the Warrior River, about ninety miles away.

The company's lines were already overloaded, so an arrangement was made to increase the power of the unit which the company was about to install at this plant. Subsequently, the Government sold its interest in this Gorgas plant to the power company, strictly in accordance with the agreement made before the work was started. This sale of the Government's interest in the Gorgas steam plant brought a rousing protest from Mr. Ford and his adherents, but it is hard to see on what grounds these protests were based, since the Government was but carrying out its original agreement with the power company.

A $165,000,000 War Baby

As a stand-by power supply for Nitrate Plant Number 2, a 60,000-kilowatt steam plant was built. This has since been rented to the Alabama Power Company on a yearly basis.

The vital factor in the power problem is the amount of water in the river. Like most other rivers, the Tennessee has periods of high water and of low water. This seasonal change is much greater than that which takes place in many rivers situated in more northerly portions of the country. During high water, in the late winter months, there will be available, it is estimated, about one million horsepower of water power at Muscle Shoals. Of this amount only 260,000 horsepower can be turned into electric power until more machinery is installed in the power house. At times during the summer, the water in the river gets so low that 100,000 horsepower is about all that can be counted on.

The amount of power which is available continuously throughout the year is called *primary power*. It is this power which brings the full market price. Power available for shorter or longer periods (less than a year) is called *secondary power*. Because of its intermittent character this secondary power is often hard to sell, even at a low price. Industries

which can use it profitably must be of such nature that extremely cheap power is more important to them than is an occasional shut down.

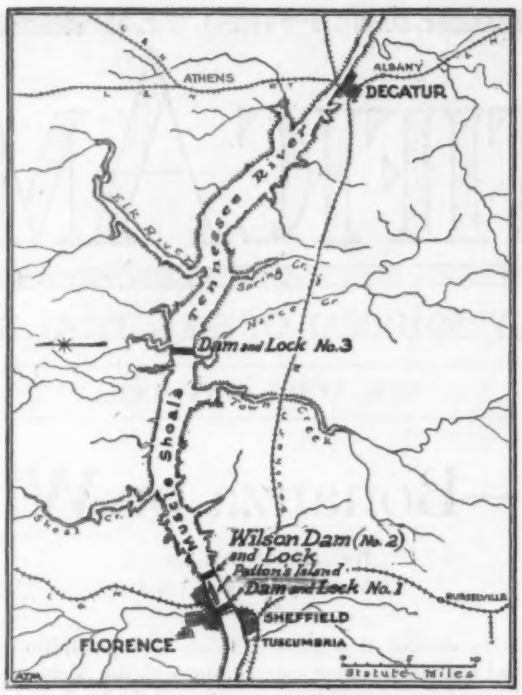
Secondary power can be converted into primary power, of course, by the use of an auxiliary steam plant, which can be run during the periods of low water and shut down again when the flow of the river becomes sufficient to carry the whole load.

What the Power Will Cost

When the Wilson Dam is completed, we will have at Muscle Shoals approximately 175,000 horsepower which can be considered as primary power. This counts in the steam plant. It has been variously estimated that this power will cost somewhere between two-tenths and four-tenths of a cent per kilowatt hour, depending on how much of the overhead due to the original investment is charged against the cost of power production. That is all the primary power which will be available when the Wilson Dam is ready to go into operation. No further increase in primary power may be looked for until Dam Number 3 is completed (three to six years hence) or until the steam plants now available are increased in size. It is easy to see, therefore, that references to "millions of horsepower" at Muscle Shoals are substantial exaggerations, unless they are taken to apply to developments in the distant future.

In this connection it may be well to point out the fallacy of the idea that water power is always far cheaper than power developed from the burning of coal. Great progress has been made in the last few years in the design of large steam-driven electric plants working at exceptionally high over-all efficiencies. The fuel cost figures, for modern plants favorably situated as regards coal supply, have gone down to a remarkable extent. For example, there is a steam-power plant now nearing completion in this country which will have an output in excess of 320,000 horsepower, steadily, all the year round. It is estimated that the cost of coal per kilowatt hour in this plant will be in the neighborhood of fifteen-hundredths of a cent. This steam plant will cost close to $50,000,000—approximately the amount of money which will have been expended on Wilson Dam when it is put into use this year. The power supplied will be nearly twice as great. The cost will be not much greater.

This covers the essential facts concerning the power developments at Muscle Shoals. We can turn, now, to what may be considered the manufacturing end of the proposition.



THE LOCALITY OF MUSCLE SHOALS

The Wilson Dam (Number 2) is the one now built. Dam Number 1 is intended to improve navigation, not to produce power. Neither it nor Dam Number 3 has been built

Practically all authorities agree that Nitrate Plant Number 1 is nearly, if not quite, useless in its present condition. It was built during the war to fix nitrogen from the air by the modified Haber process, which consisted in combining hydrogen gas and nitrogen gas under pressure in the presence of a catalytic agent. This forms ammonia gas. The hydrogen can be obtained by purifying water gas which is made from coke or it can be obtained by decomposing water electrolytically. The nitrogen is separated from the air by passing the air over red-hot coke and subsequently removing the carbon dioxide and other impurities from the nitrogen by chemical and mechanical means.

Nitrate Plant Number 2 was built to produce fixed nitrogen by a totally different process, the calcium-cyanamide process. The details of this were well known in this country at the time. Plant Number 2 is said to be one of the largest cyanamide plants in the world, its capacity being around 40,000 tons of fixed nitrogen per year. The cyanamide process employed at Nitrate Plant Number 2 starts off with the production of calcium carbide in electric furnaces. This is then treated with nitrogen from the air to form calcium cyanamide. Further treatment with lime, soda ash and steam results in ammonia gas.

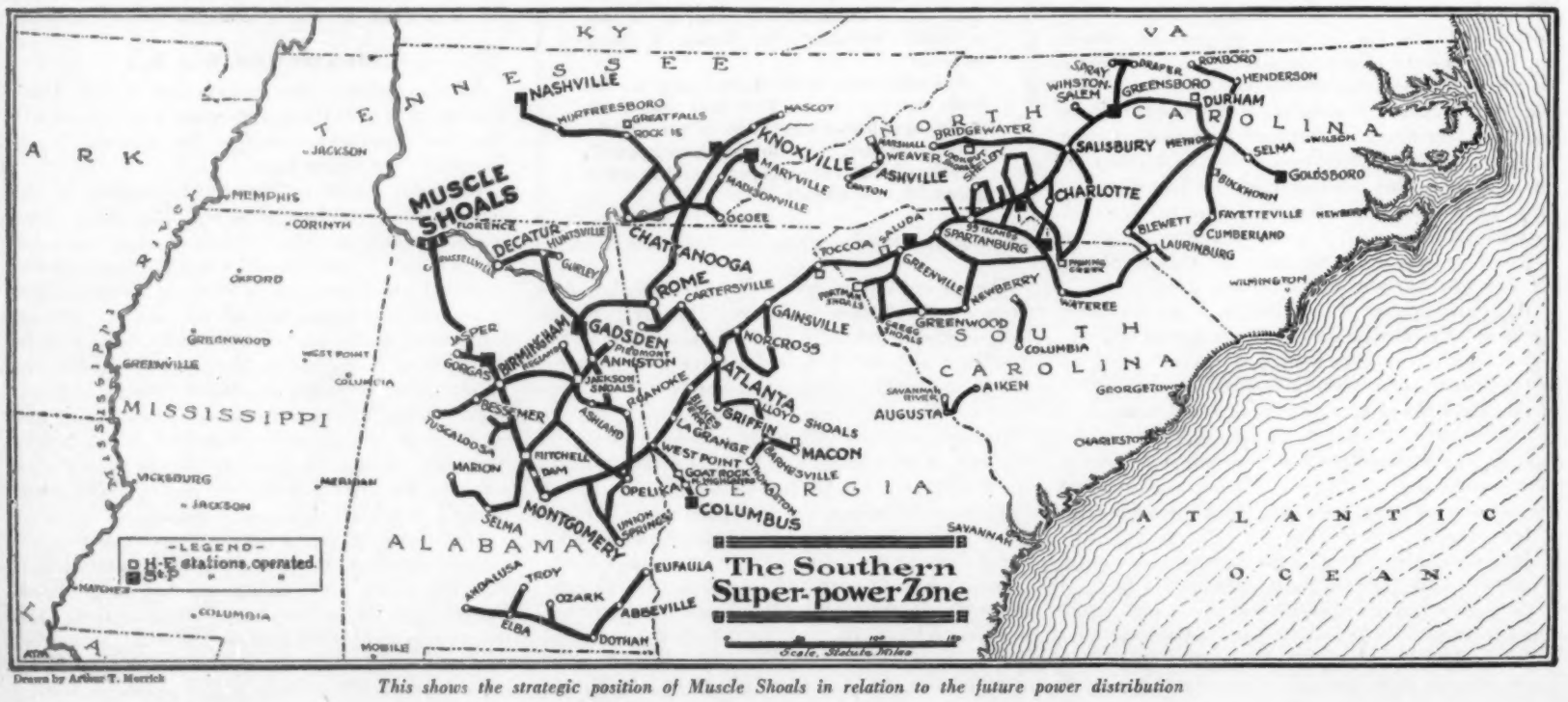
If power were the only consideration, Muscle Shoals would not present any particular problem. The Wilson Dam and its power plant could be leased to a private firm under the Federal Water Power Act. The electric power produced would naturally form part of the network known as the southern super-power plan. Fortunately the time of extreme low water is not the same for all the rivers in the south. The power generated at Muscle Shoals would tend, therefore, to increase the primary power available at all points in the network.

Can Fertilizer Be Made at All?

However, the electric power which may be available at Muscle Shoals is not the only important consideration. Many people believe that the production of cheap fertilizer is paramount. The only trouble is that the experts differ as to how this can be done, if, indeed, it is possible at all.

The mere production of fixed nitrogen does not solve the problem. Fixed nitrogen, in the form of ammonia gas, is not a fertilizer. It must first be converted into some compound which can be applied to the soil. Cyanamide itself (the product of Plant Number 2) is useful as a fertilizer without further converting but it has certain practical disadvantages which have prevented it from attaining any widespread popularity.

Since Nitrate Plant Number 1 is of little use in its present condition and Nitrate Plant Number 2 will only make cyanamide, which is not so good a fertilizer material as many other nitrogen compounds now in use, it can be seen that the problem of fertilizer production at Muscle Shoals depends largely on the working out by our scientists of some process for cheap nitrogen fixation and for its subsequent manufacture into fertilizer, which process can be used at these plants with the minimum amount of additional expenditure.



Drawn by Arthur T. Merrick

This shows the strategic position of Muscle Shoals in relation to the future power distribution

THE HUGE FACE OF THE WILSON DAM, THE ONLY DAM ALREADY BUILT AT MUSCLE SHOALS

If the flow of the Tennessee River were constant during the entire year a vast quantity of hydro-electric power would be available at this great dam and its accompanying power house. But the flow of the river is not constant and, accordingly, the power available for use all year round is much less, as is indicated by the graph below

The value of Nitrate Plant Number 2 as a producer of fixed nitrogen for war purposes has been harped upon time and again but actually it is of little importance in this connection now. Future developments will probably make it quite unnecessary so far as a war reserve is concerned. That is the opinion, at least, of Major General C. C. Williams, Chief of Ordnance of the Army. He stated in the hearings on the Muscle Shoals bills, held before the Senate Committee on Agriculture, that, due to the large increase in the number of by-product coke ovens, the production of ammonium sulphate would reach a point in a few years which would eliminate Nitrate Plant Number 2 as a necessary war reserve.

A Bid by Henry Ford

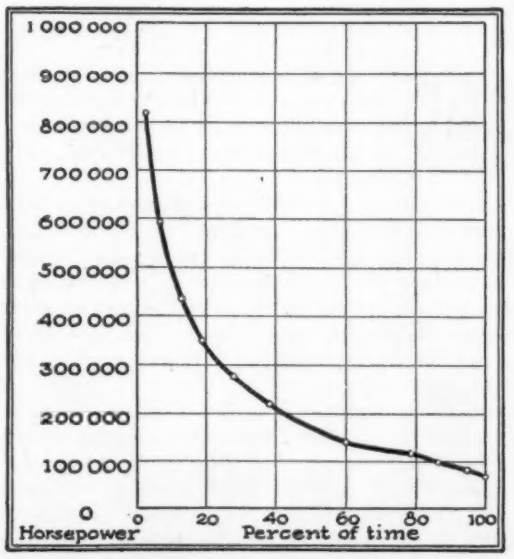
Henry Ford put in the first actual bid for Muscle Shoals and three others have been received subsequently. One was from the Alabama Power Company and its associated companies. Another was from the Union Carbide Company. The fourth was from Mr. Elon H. Hooker and associates.

A comparison of the relative value of these various bids is practically impossible. No two of them are on the same basis. However, it was quite apparent at the Senate hearing that all of the bidders except Ford had quite definite ideas about what they intended to do in the way of fertilizer manufacture. The offer of the Union Carbide Company was perhaps a bit more concrete on this point than any of the others. Their representatives stated at the hearing that they had actually acquired an option on the Lidholm patents covering the production of the chemical called urea from cyanamide and that they had worked out, experimentally, the value of the process. The obvious advantage of this method as applied to Nitrate Plant Number 2 is apparent. No change would be necessary in the equipment other than the addition of the equipment necessary to carry the process on from the cyanamide, which the plant is now equipped for, to urea.

This urea, judging from the reports which have been made on tests conducted with it, is a fertilizer material of great value. In addition, it is highly concentrated, its nitrogen content easily reaching forty-two percent in the commercial form. It would save freight for the farmers.

Another concentrated fertilizer is phosphazote, a combination of urea with phosphoric acid. Still another is ammonium phosphate, the commercial production of which will probably be quite practicable soon. The Government Fixed Nitrogen Laboratory in Washington is working steadily on these problems under the direction of Dr. F. G. Cottrell. Remarkable progress has been made so far. In fact, the developments in this field of research have been so rapid that the most advanced process today may be almost obsolete tomorrow. Most present methods of fixed nitrogen production require large amounts of power, but science now seems to be heading in the direction of processes which will require less and less power and more and more chemistry.

With this distinct possibility in mind, it seems inadvisable to tie up the power produced at Muscle Shoals for fifty or one hundred years to the production of fertilizer alone.



POWER AVAILABLE AT THE WILSON DAM

The curve shows the number of horsepower available for different percentages of the year. Less than 100,000 horsepower is available for the full year

Fertilizer is undeniably necessary. It ought to be cheap. If we could be sure that cheap fertilizer could be made at Muscle Shoals and if we were sure that it could not be made in sufficient quantity in any other convenient way, then Muscle Shoals ought to be treated, without question, as a fertilizer-producing investment on the part of the Government.

But we are not sure of these things. Indeed, the best present evidence indicates the contrary. But there is one thing that Muscle Shoals undeniably is. It is a water-power electric plant. It *can* produce electric power, although not so very cheaply and not in uniform quantity all the year round.

What We Ought to Do

Because of this variability with the season the power from Muscle Shoals ought not to be distributed or marketed as from this single unit. On the contrary, it ought to be tied in to the other power systems in the same region, so that all can be operated together to their mutual advantage; the low-water stages of one river being compensated, in part, by simultaneous higher stages of other rivers. This is merely the most obvious common sense.

Such a proposal means, in all probability, the leasing of the plant to some existing power interest, possibly the Alabama Power Company. It will undoubtedly arouse—indeed, it has aroused—the cry that a great public asset is being "sold out" to private interests. What of it? Muscle Shoals, at present, is not an asset, public or otherwise. Fertilizer is not being made there and none is likely to be made at prices that spell any important relief to the farmer. The Government does not need the plant as a war resource; the Government cannot itself make use of the power.

The plant was built for war-time needs. It is not needed any more. Let us make the best salvage arrangement that we can. The plant can be of value to the super-power supply plan for a part of the south where development is now very rapid. What better use could be made of it than that?

Brown Brothers

THE SIGNAL OF SAFETY

If you can stop your car quickly when the policeman signals to you, any driving speed is safe. If you cannot stop quickly, your speed is unsafe, no matter what your speedometer may say.

A New Plan for Traffic Laws

It Is Stops, Not Speeds, that Matter

By H. W. Slauson, M.E.

HOW large is a crowd? That depends upon where it is; fifty people might be a crowd in a small room, whereas five thousand would scarcely fill some auditoriums.

So the question of the safe speed at which to drive a car depends upon more than the rate of travel. This has been realized to a certain extent by our law makers who have specified in some instances that speeds of from thirty to thirty-five miles are permissible in the open country, and speeds of fifteen, twenty and twenty-five in cities, towns and villages.

But such laws, at best, are only a superficial attempt to remedy the evil of reckless driving. Speed in itself can no more be a criterion of carelessness, without taking attendant conditions into consideration, than can a uniform "living wage" be made to apply to all sections of the country and to all sizes of families. No one would attempt to specify, for example, that one thousand dollars is a sufficient annual sum with which to support a family, without taking into consideration whether such family is large or small or is to be raised in a rigorous climate where fuel and clothing are important items of expenditure or in the sunny south where such outlays are not necessary.

And yet, is it not just as illogical to say that speeds in excess of thirty miles per hour on an open country road represent presumptive evidence of carelessness, and not to take into consideration whether that road is slippery or dry, whether the car is equipped with good or bad brakes and whether the driver can obtain an unobstructed view for a sufficient distance in advance to permit such speed?

What we really intend to do when enacting speed laws is to insure that the driver will have the car under control at all times. Adequate control of the car means the ability to bring the vehicle to a *dead stop* within a distance short of the danger line. For example, a car may be considered to be driven with due care if it can be stopped within four or five hundred feet on an open country highway on which other vehicles, pedestrians or any obstruction can be seen at least one thousand feet ahead of the car. On the other hand, a car traversing a school street,

on which a child might dart into the roadway thirty feet ahead, should be driven at such speed that it may be stopped within fifteen feet—and all of this regardless of the rate at which the speedometer may say that the car was traveling.

It will be noted that I have made the stopping distance equal to one-half of the distance between the car and the place of the danger. This is not only to give a "bridge builder's factor of safety" but also to provide for the inevitable lag which occurs during the mental processes necessary to observe the danger and to apply the breaks. Experiment has proved that at least two-fifths of a second is required to remove the foot from the accelerator pedal and apply it to the brake. The danger may not be mentally translated as such for another second, and the action of the foot might not be instantaneous and positive when a driver is under the stress of high-speed travel.

Two Seconds Delay

It is certainly not too much to assume, therefore, that two seconds may elapse between the appearance of the danger and the effective functioning of the brakes at the wheel. During these two seconds a car driven at fifty miles an hour will have traveled practically one hundred and fifty feet before it begins to slow down. Charts, which we see published frequently by a well-known brake-lining manufacturer, indicate that two-wheel brakes, in good condition should serve to bring a car to a dead stop within two hundred and thirty-one feet when traveling at fifty miles an hour. This distance, added to the one hundred and fifty already mentioned, amounts to nearly four hundred feet, which may be taken as the distance required to bring a car to a stop under average conditions and when traveling at fifty miles

Brown Brothers

THE RESULT OF A SKID

Car speed must be regulated by the driver to suit the condition of the road, the brakes, the tires and the weather

an hour. Almost instantaneous brain and muscular functioning and the use of highly efficient brakes might cut this distance in half under the best of conditions. But the higher figure represents the day-in and day-out average of the majority of cars. It is this with which we must deal.

The action of brakes is merely to absorb the momentum of a heavy moving mass, as represented by the car. Momentum, in a horizontal direction, depends upon two factors; weight and speed. For ordinary purposes mass may be considered the same as weight. Accordingly, the momentum of a car varies directly as the car's weight and as the square of the speed. The mathematical formula is:

$$I = mv^2,$$

in which **I** equals the momentum, **m** equals the mass (or weight) of the car and **v** equals the speed.

Since it is momentum which tends to keep the car going and which must be absorbed, by the brakes or otherwise, before the car can be stopped, it will be seen that, given the same retarding effect, a car weighing four thousand pounds will require double the braking effect to be brought to a stop as that necessary for a car weighing but two thousand pounds.

By the same formula, we observe that if we double our speed, we increase the stopping distance required, not by twice, but by four times. And if we are traveling, for example, at thirty miles an hour, we will need nine times the distance in which to stop that would be necessary if we were traveling at only ten miles an hour.

Now, although it is very evident from the above that speed exerts a tremendous influence on the effort required to stop a moving automobile, the factors of brake condition, driving ability and nature

Will the "Short-stop" Replace the Speed Limit?

In this article Mr. Slauson suggests a new and revolutionary plan for abolishing the legal speed limits for automobiles. The plan has been called the "Short-stop" Plan. We predict that you will be hearing more about it as this summer goes on.

Automobile traffic must be made safer. The problem grows daily more pressing. Drivers and makers of automobiles must solve it or face increasing public opposition.

This "Short-stop" Plan may be the right solution or it may not be. At least, it merits full discussion and test.

Do you think that the plan would work? If not, why not? Shall the Scientific American advocate its adoption by law? Write us what you think about these questions. Ask your friends what they think. Ask them to write us too.

Will he be less necessary?

of the road surface are equally important. However, except insofar as some motor vehicle laws require periodic brake inspection, safety and care in driving are almost entirely translated, in the public mind and in the law, into miles per hour. There is no other reference to the really vital factor of "how quickly can the car be stopped."

Not only that, but, in order to avoid the possibility of unfair persecution of the automobilist, the laws of many states make the wise provision that evidence must be presented to indicate that the offending motorist exceeded the speed limit for a sustained distance of one-eighth of a mile in the city or one-quarter of a mile in the open country. Of course, one of the purposes of this provision is to enable the motorist to overtake a slow lumbering vehicle ahead of him by means of a short burst of speed which will keep him on the wrong side of the road for a minimum period of time.

Brown Brothers

WHERE SAFE CONTROL IS ESSENTIAL

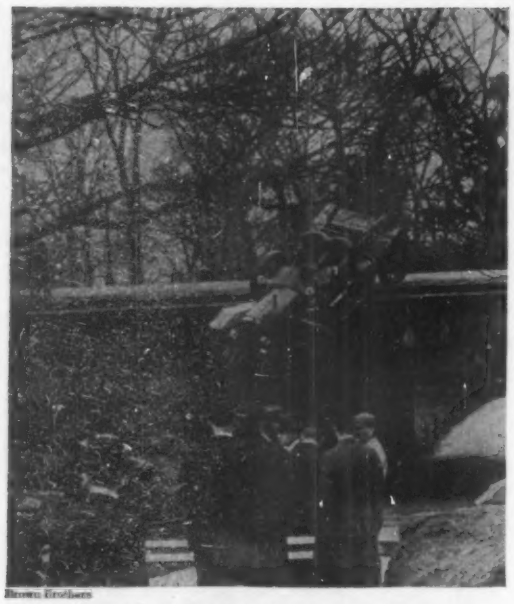
At schools and in school streets there are now many accidents which speed laws do not succeed in preventing

The usual means for enforcing speed laws is the "motorcycle cop." The motorcycle is a two-wheel vehicle. As such it is not as steady on its legs as is its four-wheel prey. This means that during wet and snowy weather, when speeding becomes most dangerous, the motorcycle enforcement officer must suspend activities. In consequence, during certain summer weather when driving is safest because stopping conditions are best, arrests for minor violations of the speed ordinance are most numerous. On the other hand, in wet or freezing weather, when even speeds well under the allowable limit are most dangerous, there are but few arrests or summons for careless driving.

Twenty-five Miles—Twenty-five Dollars

Now a law which employs speed as the sole criterion of careless driving and which makes no differentiation between good and bad brakes, between smooth or non-skid tires, and between dry or wet or icy pavements, evidently fails in its purpose of promoting maximum safety of driving. If the cure were impossible or were worse than the disease, we would have no criticism to make, but the remedy is so simple and can take into consideration so easily and automatically the various conditions which we have mentioned as affecting the safety of car operation, that we marvel that seventeen million cars are still governed in their activities by such antiquated laws as to permit, "Twenty-five miles an hour, Your Honor," "Twenty-five dollars fine, Mr. Defendant," to be the stereotyped sound issuing from thousands of court rooms.

So long as it is the inability to stop in time which is the cause of most accidents and the reason for all speed laws, let us go directly to the source of the trouble. Let us require that every car shall be driven only at such a rate that it may be brought to a complete standstill within specified distances; these distances varying with country and city driving conditions much as do the variable speed rates now



Brown Brothers

THE SPEED WAS MISCALCULATED

On narrow roads, across bridges, and in similar dangerous places it is especially necessary for the driver to guage his speed for a quick stop

permitted. We could stipulate, for example, two hundred feet as the required stopping distance on an open country road; fifty feet in some sections of the city; even fifteen or twenty feet in the more congested portions. We could mark all school streets as "ten foot zones" indicating that on such streets the motorist must have his car under such control at all times that it can be brought to an absolute stop within ten feet after the danger has been noted or after a prescribed signal has been given.

One of the principal values of such a system is that it would take into consideration, absolutely and automatically, all conditions then prevailing which would affect the stopping ability of the car or of the driver in question. On a slippery road and without chains, the driver would need to exercise much greater care and would dare drive, possibly, at only a quarter of the speed that would permit stopping within the same distance under good conditions on dry roads. The design and condition of the braking mechanism would represent, also, a vital factor in determining the speed at which the car might be operated without danger of violating the stopping-distance provision.

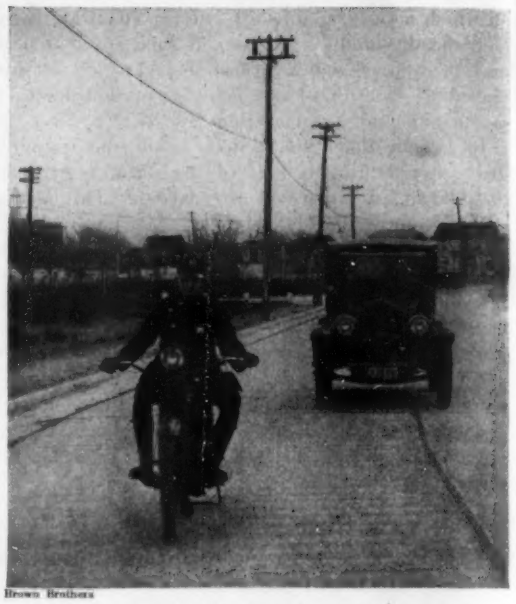
The operating machinery for such a method of speed regulation would be much simpler and more effective than that employed at present. Quibbling over the inspection and accuracy of speedometers and disputes as to the distance over which the speed-limit had been exceeded would be avoided. All that might be necessary for proof of careless driving would be a tape line and possibly a piece of chalk. No expensive motorcycles or high-speed cars are needed, nor any highly trained body of "motorcycle cops." Every patrolman could produce the necessary evidence of careless driving.

Suppose, for example, that a patrolman, roundsman or other ordinary police officer on foot is walking on what is known as a "twenty-foot street"—this meaning that any vehicle driven on that street must be operated at such a speed that it can be brought to a dead stop within twenty feet. The pavement is wet. The policeman sees a car approaching at what he considers to be a dangerous speed. He need only step to the curb, raise his hand and blow his whistle. If the motorist is able to bring his car to a complete stop within twenty feet from the point at which the prescribed signal was given, he has demonstrated that he was driving carefully within the meaning of the law. It is inconsequential whether his speed was ten or twenty miles an hour, whether he used chains or non-skid tires or whether his car was provided with two- or four-wheel brakes. Those matters are entirely his own business. He has passed the test.

A Slide Convicts of Carelessness

If, on the other hand, when the motorist hears or sees the signal to stop and applies his brakes, he finds that his car slides for thirty feet, it is obvious that he was driving "carelessly" in that his speed was too high, his tires too smooth or his brakes insufficiently effective to bring the car to a stop within the prescribed distance. Whatever the cause, he should suffer the consequence.

Such a system would not necessarily dispense entirely with the services of the motorcycle enforcement officer. It would, in fact, add to his efficiency in apprehending the careless driver. High-speed



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READY TO GIVE THE SIGNAL

If a motorist does not stop when ordered to do so for a test of stopping distance, the motorcycle officer is there to give instant chase

motorcycles may be used to overtake those who ignore the signal to bring their cars to a stop. Furthermore, no motorist will dare deliberately to break the speed law through his present trust in the effectiveness of his rear-view mirror. As long as the motorist of today can obtain a clear view of the road behind and as long as he knows that he must be chased by a duly constituted officer with a properly inspected speedometer for a distance in some instances of at least one-quarter of a mile, many a driver who should be apprehended is never "caught in the act."

As long as we have automobiles, we will have the eternal discussion of what constitutes a safe driving speed. There is but little room for argument, however, as to what constitutes a safe stopping distance. This stopping distance represents the entire basis on which safety depends.

Why not adopt the plan of using this stopping distance, not a speed limit, as the sole method of judging the carelessness of car operation?

Drawn by Arthur T. Merrick

STOPPING RESISTANCE AS AFFECTED BY WEIGHT AND SPEED

The sizes of the policemen indicate the relative amounts of momentum which must be absorbed in stopping the cars at the various weights and speeds. Note how greatly the 60-mile speed increases the stopping resistance

Brown Brothers

HOW STREETS MAY BE MARKED FOR THE NEW PLAN

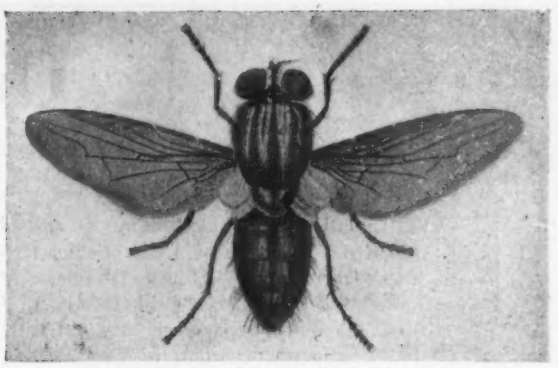
Figures painted on the pavement may be used to inform drivers of the distance within which they must be prepared to stop their cars while on that particular block. These distances would vary, of course, with the density of traffic

Locust Fighting

A Battle that Man Never Wins, But Never Gives Up

Millions of grasshoppers or locusts, corraled by means of a barrier of sheet metal, and driven through a short opening into a trench whose sides are enclosed by overhanging strips of zinc. Later they will be destroyed by fire

Waiting to be burned. Two hills of locusts gathered in the traps of the Argentinians. In many parts of North America locusts are commonly called grasshoppers; while the insect frequently mistermed the locust is really the cicada



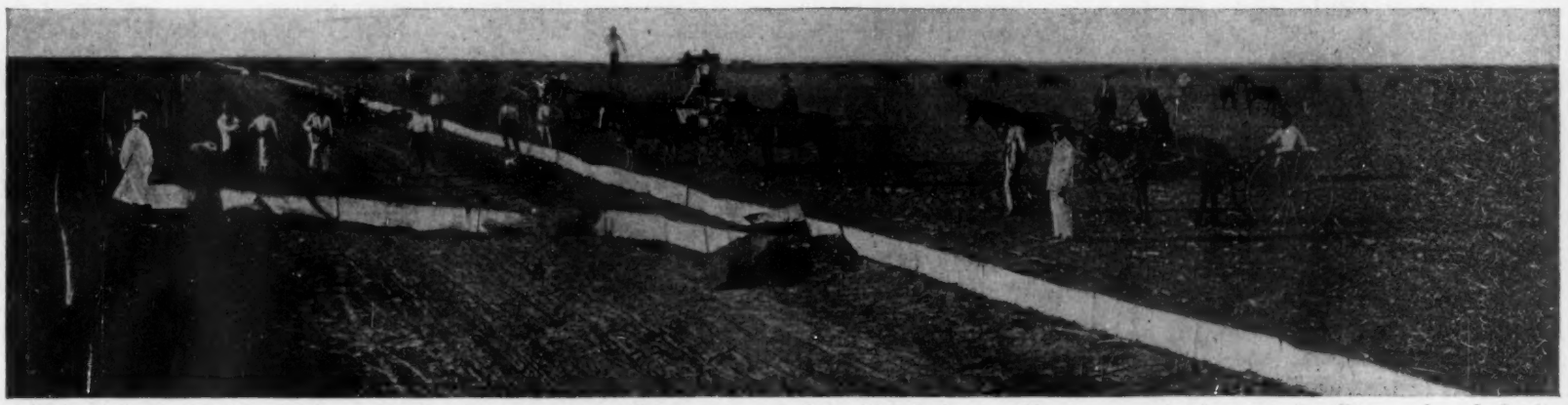
The fly that lays her eggs in the live locusts killing them by the millions

MAN happens to live in the age of insects. No other branch of the tree of life includes so many species, for if we take the word insects in its commonest sense there are at least three hundred thousand species of them. When man invented agriculture the locust or grasshopper became one of his greatest enemies. Like advancing armies these little creatures migrate in swarms that sometimes literally becloud the face of the sun. In their path they leave naught of vegetable life but desolation. Crops, grass, the foliage of trees and all that grows from the soil is eaten and disappears in a day as if the earth had been blasted by a giant torch.

In the Argentine Republic locusts, or grasshoppers, are so persistent a pest that the government includes a special department, the Agricultural Protective Department, for coping with their migrations. This department is always organized, for the locust is always existent in the Argentine. The most practicable method of giving battle to the locusts consists of driving them into sunken traps, where they are burned. In this manner no less than 35,000 tons of locusts were destroyed in a single season.

Recently a natural enemy of the locust was found, a true insect which pursues them on the wing, depositing her eggs within the bodies of the swarming migrants. These eggs hatch into maggots which kill their hosts. When this happens the armies of locusts dwindle into scattered, straggling groups.

Unfortunately, however, the attacking fly must dwindle with the locusts, for they will lay their eggs in no other place than the bodies of live locusts. Thus the fly is never able to wholly exterminate the locust pests. Perhaps, suggests Mr. Leonard Matters, writing in the *Illustrated London News*, the flies and the locusts will some day disappear together, the last fly killing the last locust and thus depriving its own offspring of its food.



A barrier of sheet metal, fifty miles long, and a funnel-shaped trap into which the locusts are being driven by beaters. These traps are placed at convenient distances along the barrier. The whole countryside becomes interested in the all-important work, for in an agricultural community everyone's welfare depends on the growth of plant life

Our Point of View

The War Department Decides

LAST month we had something to say about the diversion of Lake Michigan water through the Chicago drainage canal; this month we are able to report that the War Department has taken hold of the problem in no uncertain way and has told Chicago "where it gets off." For five years to come Chicago will be permitted to divert the full ten thousand feet per second of Lake Michigan water which the drainage canal can accommodate, but she may do this only on condition that she not only carries through the sewage purification program which the city has already promised, but she must give her bond that she will participate with other cities in the matter of lake control, and she must put in a system of meters before the War Department will allow a full diversion from the lake. This order of the Secretary of War has the authority of the United States government behind it—in other words it is mandatory, and what it requires the city of Chicago must carry out.

Up to the giving of the present order Chicago has been diverting far more than the 4,167 feet per second allowed; the present order requires a reduction in this amount, presumably in proportion as the sewage disposal works are built, to 4,167 second-feet by 1935. We have always been of the opinion that the reversal of the flow of the Chicago River and the diversion of Lake Michigan water through its channel was a mere make-shift. The wise course for Chicago is to set about the construction of sewage disposal works that will take care of the future growth of the city. The present order of Secretary Weeks makes this plan imperative.

Definite Facts on Railroad Electrification

THE electrification of the steam lines of the country is very much before the public in these days, and we have frequently been asked whether it will be possible to electrify the whole 260,000 miles in this country and if such work would be economically practicable. The answer is that it would be quite impossible, at least under existing financial and operating conditions. For special regions such as the terminal zones of large cities, where more often than not the law compels the change from steam to electricity, and in certain mountain divisions of the railroads where power, hydraulic or otherwise, is conveniently available, electrification is practicable and shows more or less economic superiority over steam traction; but for long stretches of railroad running through sparsely inhabited districts, electrification, unless there should be very radical changes in the art, will be impracticable for many a decade to come—if at all.

Everybody has heard of the important electrification, by the Chicago, Milwaukee and St. Paul Railroad, of a long stretch of its mountain division, and thanks to a recent report the public is now put in possession of the actual economic facts as ascertained through several years of electric traction. The change from steam to electric power on the first 438 miles of line was made in 1916, and 210 additional miles were electrified in 1920, the total 648 miles calling for a capital investment of $15,625,739. As compared with steam operation there has been a total saving by electric operation, from 1916 to 1924, of $12,400.007, representing eighty percent of the total capital charge. We are told that this result was obtained in a little over eight years over two-thirds of the electrified line, and in a little under five years over the other one-third. This means, that, at the same rate, electric operation will show at the end of 1926 savings sufficient to cover the carrying charges on the road's additional investment, and to cover also the entire cost of electrification.

The significance of the report will be realized when we remember that it is not based on estimated savings and estimated operations, but on actual figures which cannot be gainsaid. We must remember that these excellent results were obtained under the distressing conditions which followed the great war, and it is certain that under more favorable conditions, when cost conditions are lowered and a heavy and stable traffic can be depended upon, even these fine results will be improved. The Milwaukee and St. Paul experiment is certainly encouraging for the further extension of the electrification of steam railroads.

Committee Says St. Paul's Is Safe

THE committee of three engineers and two architects, all of high rank in their professions, after three and a half years thorough examination of St. Paul's, have made a decidedly reassuring report as to its stability. In the first place they state that what settlement has taken place occurred during the course of erection over two hundred years ago. They find proof of this in the fact that the builders inserted "compensating courses" of masonry—that is thicker courses—at three points in the height of the building, to bring it back to the perpendicular, so that today "the base of the lantern" above the dome "is still horizontal and its axis vertical."

So far so good. But when the committee goes on to attribute the cracks in the structure to temperature changes, American engineers will smile; the more so when they are told that the annual variation in the diameter of the dome, due to temperature variations, is one-sixteenth of an inch. With some knowledge of what has happened to rubble-filled and eccentrically loaded piers in other English cathedrals, we protest against this naive placing upon Dame Nature's shoulders a burden of blame, which should be carried by Wren, or, more likely, by his parsimonious building committee.

The committee does not believe that the load of the dome is placed eccentrically upon the piers; they speak of the "internal arch" action of the drum distributing this load, whatever that may mean. No internal arch theory can get round the facts (1) that the eight arches do carry the whole weight of the drum; (2) that the piers do carry the arches; (3) that the drum is positioned above the inner edges of these arches and (4) that the load thus received is transferred to the piers at their inner edges, thus causing the cut-stone masonry, or ashlar, to carry practically the whole load.

Most amazing is the statement of the committee that the thirty-two buttresses "do not play an important part in distributing the load over the" whole thirty-foot "width of the piers," and that "*it is undesirable that they should do so.*" If so, why in the world did Wren put them there; and again, if so, why did the drum, as it sank, make such an effort to spread its load over the whole pier, that it sheared the massive buttresses entirely through.

However, it is gratifying to learn from this report that the subsoil is consolidated and proof against further settlement, and that grouting will render the piers as sound as when they were first erected.

We Have Sufficient Helium

WE are pleased to learn from no less authority than Dr. Richard B. Moore, former chief chemist of the Bureau of Mines, that we possess an abundance of helium gas within the United States, sufficient, he says, "to keep filled and ready for service 200 airships of the size of the Shenandoah." He predicts that within a few years airships of twice her size will be built, (England is now building two of 5,000,000 cubic feet capacity) and that they will be capable of carrying sufficient fuel for the round trip to Europe, and still have reserve buoyancy for a good load of bombs.

It is the safety from destruction by fire that renders helium the greatest promoter of commercial airship travel that has been developed in the history of the art. The horrible disasters to hydrogen-filled ships have left an indelible impression on the public mind. The helium-filled ship is practically indestructible; for the mooring mast, reliable motors and water recovery have made uninterrupted progress sure and landing crashes a thing of the past.

The natural gas of Texas affords a vast source of supply, and satisfactory methods have been devised for the separating out of the helium. The repurification plant at the Lakewood Naval Air Station works so well that a gas nearly one hundred percent pure is secured. The high cost of the gas, as first produced, has been cut down over sixty percent, and a further reduction may be expected. Airship transportation of passengers, mail and light freight is a certainty. How soon it will come is a question of legislation, finance and judicious promotion.

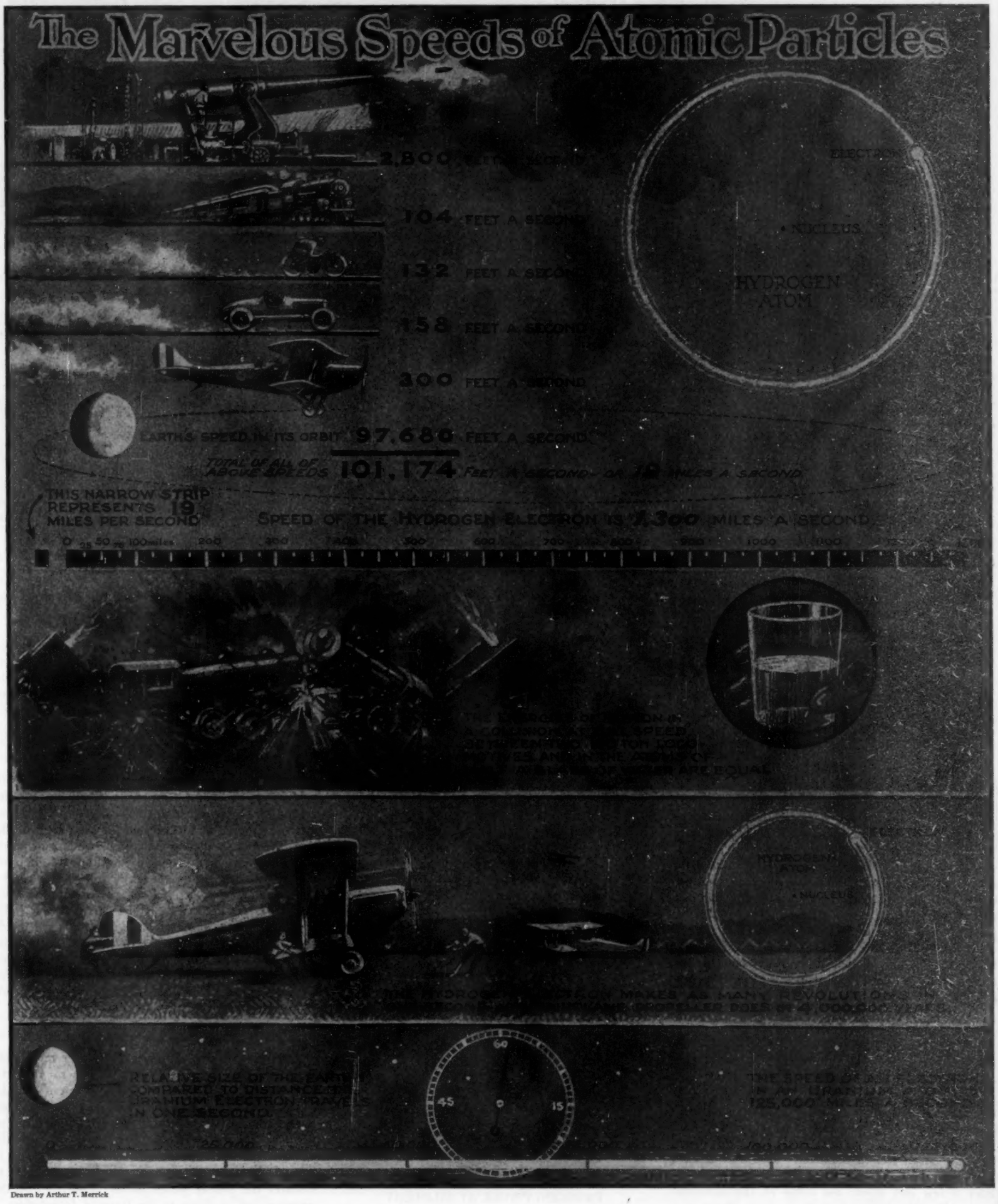
Guarding Against Water Famine

WE hope shortly to show what New York City has done to protect itself against any possible water famine. This security, at the present rate of growth of population, will last until the year 1935; but at that time the use of water will exceed the safe yield of the then existing sources of supply. A conservative estimate by the Board of Water Supply places the population of this city ten years from now at 7,600,000 people. The rate of consumption is 135 gallons per capita per day; it is slightly increasing.

Prudence demands that the city at once take preliminary steps to secure a water supply additional to the 1,036,000,000 gallons now available. New sources of supply of excellent drinking water can be provided on the west side of the Hudson by raising another dam on the lower Schoharie and by the development of Catskill Creek. This would provide an additional 500,000,000 gallons per day; and a development of the streams in Dutchess, Columbia and Rensselaer Counties on the east side of the river, would yield another 350,000,000 gallons.

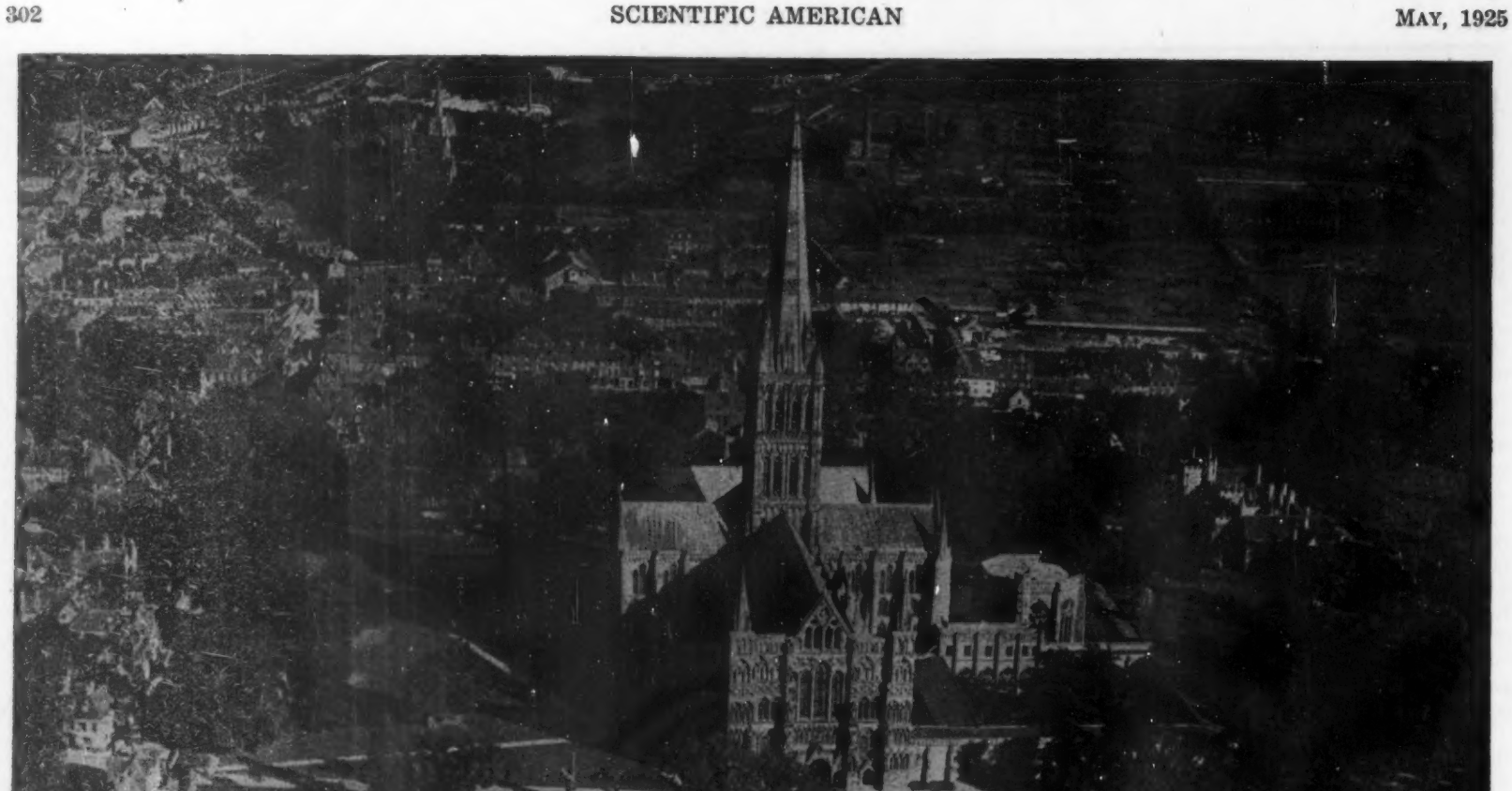
When the city has grown to the extent predicted, it must fall back upon the great catchment basin of the Delaware River. An equitable apportionment of the waters of this great river is being sought in a compact between the three states concerned, by which New York will be assured of 1,500,000 gallons per day of water of the same quality as that of the Catskill system. New Jersey will secure the same quantity, and Pennsylvania will have at its disposal 3,000,000,000 gallons, which it can use at such time and in such quantities as its various cities may require. The compact merely defines the rights of the states and it should receive the unanimous support of the three legislatures concerned.

J. B. W.


The Marvelous Speeds of Atomic Particles
2,800 FEET A SECOND
104 FEET A SECOND
132 FEET A SECOND
158 FEET A SECOND
300 FEET A SECOND
EARTH'S SPEED IN ITS ORBIT 97,680 FEET A SECOND
TOTAL OF ALL OF ABOVE SPEEDS 101,174 FEET A SECOND OR 19 MILES A SECOND
THIS NARROW STRIP REPRESENTS 19 MILES PER SECOND
SPEED OF THE HYDROGEN ELECTRON IS 1,300 MILES A SECOND
ELECTRON
NUCLEUS
HYDROGEN ATOM
RELATIVE SIZE OF THE EARTH COMPARED TO DISTANCE THE URANIUM ELECTRON TRAVELS IN ONE SECOND
125,000
60
45
0
15

Drawn by Arthur T. Merrick

The atoms of matter are so tiny that many millions of them can crowd together on the surface of a pinhead. Nevertheless, inside each of these atoms are still tinier particles called electrons. The electrons revolve around the atomic nuclei much as the planets revolve around the sun. The speeds of the electrons vary in different kinds of atoms, as is illustrated above. Other pictorial representations of atomic wonders were printed in our February issue.



Central Aerophoto Company, Ltd.

SALISBURY CATHEDRAL FROM THE AIR

Built in 13th Century in forty years' time. Original tower rose only ten feet above roof. The erection of tower and spire a few years later made this the tallest spire in England with a total height of 404 feet. The extra weight of several thousand tons threatened the fall of the spire and the destruction of a large part of the whole building.

Saving St. Paul's Cathedral

Failures of Medieval Cathedrals Foreshadowed the Present Trouble at St. Paul's

By J. Bernard Walker

TO any serious student of the history of medieval cathedral building there will be something very familiar in the published descriptions of the present condition of the fabric of St. Paul's Cathedral, London. It is no disparagement of the artistic skill of the cathedral builders to say that much of their work was constructionally faulty and that not a little of it fell down during or soon after completion, and had to be rebuilt. There is scarcely a cathedral in England that does not contain re-enforcements in the shape of stone beams, braces, arches and buttresses that were never contemplated in the original design.

Piers Sank Several Inches

In proof of the above we submit several views showing some important emergency work of this character. Because of the great concentrated weight of the central towers most of this re-enforcement is to be found at the central crossing. A notable instance is Salisbury. The four main piers or "legs," which carry the load of the central tower and spire, are only seven feet in diameter. This should have been sufficient for the original tower whose top rose only a few feet above the ridge of the cathedral roofs. But after the cathedral was built, the bishop in charge decided to place upon the existing tower two additional stories with a total height of eighty feet, and above this he ran up a spire which in itself is 200 feet in height. Inevitably, trouble developed. The overloaded piers sank several inches into the ground, and to prevent the piers from buckling they put in the two arches shown in our illustration, to say nothing of a multitude of inclined buttresses both inside the cathedral and out, the aggregate crossing-sectional area of which ultimately became larger than the original area of the walls of the tower. A dozen or more iron and steel bands and ties have been built around and within the tower and spire. In spite of the winter gales this audacious spire 405 feet high, has stood for some six or seven centuries and, if carefully looked after, should stand for as long a period in the future.

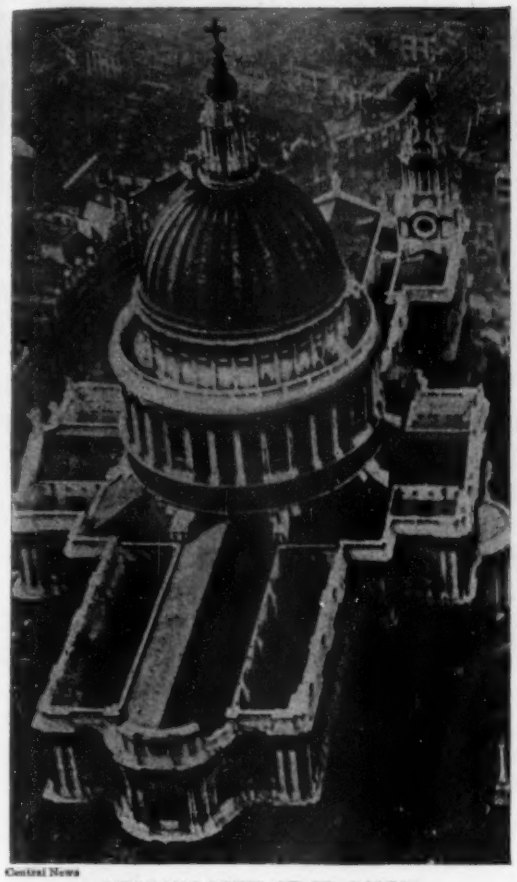
EMERGENCY WORK AT SALISBURY

Additional load of tower and spire threatened collapse of the tower piers. The lower arches added to prevent inward bending and collapse of piers

Fall of Towers a Common Occurrence

The massive central tower of Gloucester Cathedral, weighing some 4,000 tons began to push the walls of the nave, choir and transepts out of plumb; so the medieval masons built inclined buttresses both outside the walls and within them, and they did so without any regard to appearances; as witness, the enormous buttress crossing the arched entrance to one of the transept chapels, which is designed to transfer the lateral thrust of the tower, across the opening and so down to the transept foundation.

The fall of the central tower of a cathedral was a common occurrence. Not a few of those which we



Central News

AIRPLANE VIEW OF ST. PAUL'S

Note the great height and mass of the dome in comparison with the rest of the building. The dome is in good condition, but its weight of 40,000 tons is crushing the piers of indifferent masonry which support it. The latter are being grouted with cement to bind together the disintegrated rubble-filled interior of the piers

see today were rebuilt in medieval times or even as late as the Nineteenth Century. One of the most beautiful of English cathedrals is Wells, whose central tower, even while it was being built, proved too heavy for the foundations and sank many inches, shearing loose from the adjoining walls of nave and transepts. Hence the series of double arches, as shown in the illustration. These were, of course, never contemplated in the original plans, and they stand as an evidence of the lack of knowledge of these early architects and masons of the strength of materials, and of the nature and amount of the stresses to which their buildings would be subjected upon completion.

And Now St. Paul's

Not alone did the central towers come down, but frequently other parts of the cathedral would collapse. Evidence of this is seen in our view of the western front of Ely. Originally it included a complete transept whose westerly face was flush with the westerly face of the tower. The north and the south transepts were identical; but due to some cause—whether faulty foundations or careless construction—the north transept collapsed.

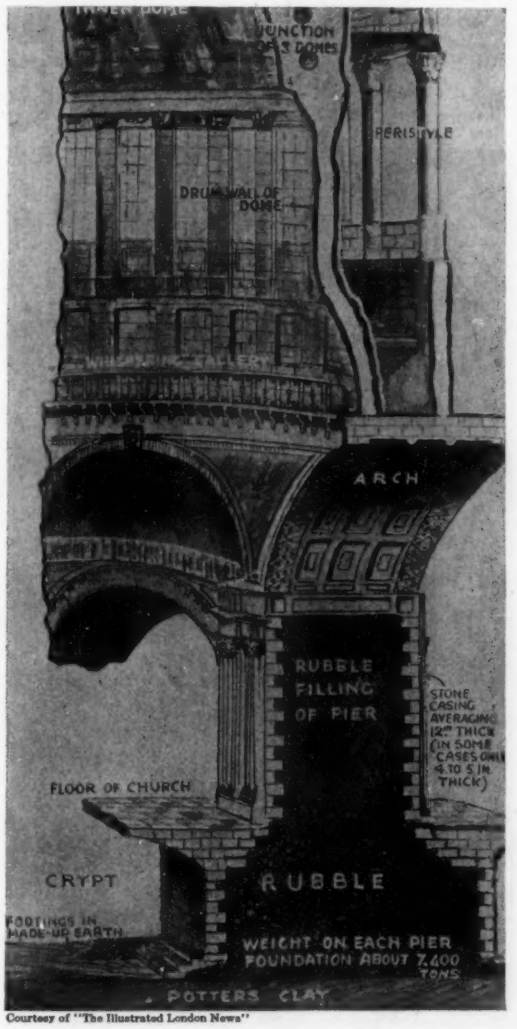
The troubles of the medieval builders must be classed under three heads—first, a lack of knowledge of the actual bearing strength of the natural materials under the foundations; second, a lack of knowledge of the compressive and shearing strength of rubble-filled walling; and thirdly the unreliable character of the lime which they used in the rubble work core of their piers and massive walls. A considerable amount of clay is found in the English lime, and this in the course of centuries disintegrates and leaves the mortar in a more or less porous and broken down condition. The early builders evidently were not aware of this defect and chemical testing laboratories were not available in that day.

We should not be too hard upon the masons of medieval days.

Compared with the medieval buildings St. Paul's, completed about 200 years ago by Wren, is a comparatively modern building; nevertheless it is presenting the same problem of faulty masonry and at the same place—the crossing of nave and transepts. Unsatisfactory subsoil, and inferior masonry, acted upon by the enormous concentrated load of the dome, have caused the piers to settle unevenly with resulting cracks throughout practically the whole of the masonry of the dome. Over one million dollars for repairs have been raised by popular subscription, and the authorities are carrying out protective measures which will remove all immediate anxiety as to the security of the dome.

Wren Not to Blame

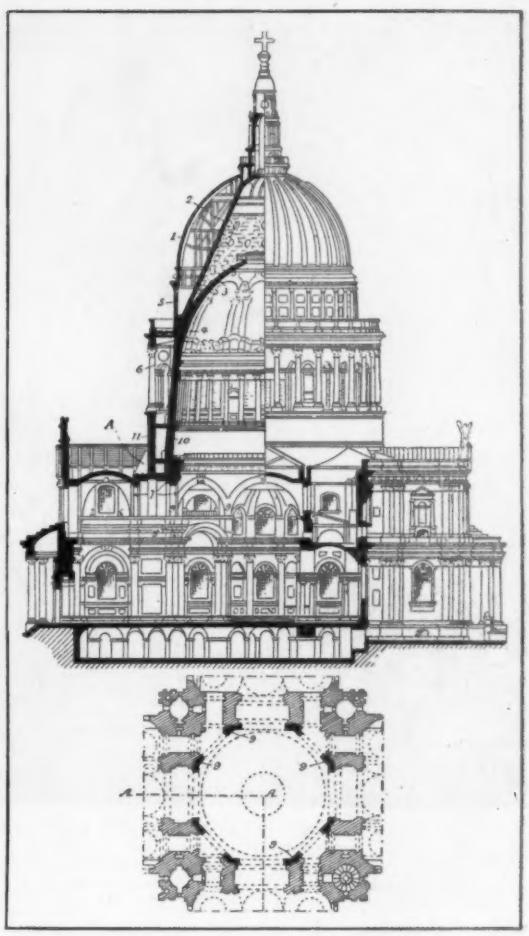
And just here let us absolve the great Wren from blame for the present conditions. When he undertook to design and build St. Paul's, he was not a builder; but he was one of the most brilliant mathematicians of his day and the fabric of the dome, fractured though it be, shows that he had a perfect knowledge of the amounts and the direction of the stresses. When he started the great church he was not familiar apparently with the strength of built-up masonry and he did not realize how ill-suited a masonry wall is to stand a vertical shearing stress. His piers are built in the medieval fashion, consisting of an outer veneer of cut stone from 6 to 12 inches in thickness filled in with rubble masonry. Speaking of the building of these piers, the eminent engineer, Sir Francis Fox, says that he is led to the conclusion that a kind of large rectangular bath was formed of the outer cut stone. This was filled with lime, and into the liquid bath the stone debris from old St. Paul's was dumped without any attempt to bed the material. Recent examination shows that in some cases the rubble can be moved between finger and thumb, the mortar having more or less completely disintegrated.



Courtesy of "The Illustrated London News"

ONE OF THE RUBBLE-FILLED PIERS

This shows how the weight of dome and drums is carried down to the piers by eight arches. Note the outer cut-stone facing which is carrying most of the load and the inner rough rubble of the piers



SECTION AND GROUND-PLAN OF ST. PAUL'S

This shows the outer timber-and-lead dome (1), the brick cone (2) which carries the stone lantern, the inner masonry dome (3) and the peristyle (6). This load of 40,000 tons is carried down by eight arches to eight piers, where it rests, and bears mainly on their inner edges 9, 9, 9, and has badly crushed them

The present serious condition of the dome and substructure is due to three causes, (1) the uneven compression of the subsoil, (2) the poor material of the piers, (3) the concentration of the weight of the dome, estimated at 40,000 tons, upon the inner edges (instead of the whole width) of the eight piers that carry it.

Liquid Cement Solves the Problem

Wren's foundations rest upon a layer of five feet of potter's clay, between which and the splendid London blue clay (a distance of 25 feet) is a mass of sand and gravel. Sand makes an excellent foundation provided it be prevented from escaping laterally. Unfortunately, excavations for a large sewer adjoining the cathedral were started one hundred years ago through this sand, and during the operation hundreds of tons of sand and water flowed into the excavation and were removed. This of itself would be sufficient to cause subsidence of the piers. Fortunately this subsoil can be made into a perfectly satisfactory foundation (a kind of conglomerate) by grouting it with liquid cement under high pressure, as was proved by Fox in an experimental boring near the cathedral. The piers also can be made

WEST FRONT OF ELY CATHEDRAL

Originally this front showed both north and south transept. The north transept fell and its place is taken by the inclined buttress, placed there to prevent fall of tower

NAVE OF WELLS CATHEDRAL

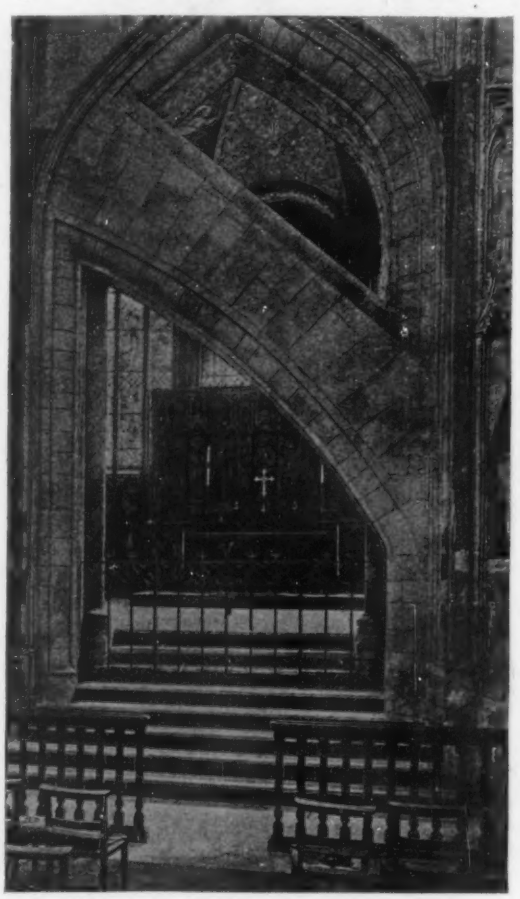
The heavy central tower of Wells (like many another) sank into the soil and threatened to fall. The curious double arch represents emergency work to save the tower

secure by washing the interior rubble with steam and then injecting cement until the cavities are filled and the rubble work is firmly cemented to the outside cut-stone facing. This has been done during the last 75 years to a dozen or more English cathedrals, and they have been rendered thoroughly secure. From what we have said it will be seen that grouting alone, if most carefully and conscientiously done, will provide a solid and in a sense a monolithic foundation from the London blue clay to the top of the piers which carry the dome.

The Construction of the Dome

The outer and inner drums of the dome, and the dome itself weigh, as we have said, about 40,000 tons, which means that each of the eight piers has to carry a load of about 5,000 tons. Thus, when they have been thoroughly grouted in the way described, they would be perfectly able to do, *if the weight of the dome was distributed fairly and evenly over their whole cross-sectional area; for the piers are 11 feet by 30 feet.* Unfortunately as matters now stand the load of the dome proper is concentrated on the inner edges of these piers and, because of the compressibility of the disintegrated rubble work, the load is naturally carried by the incompressible cut-stone facing that fronts upon the central area of the dome. It is estimated by British engineers that this stone is loaded over 50 tons per square foot. Personally, we believe that the load is much greater than that, and the evidence of these stresses is seen in the fact that from time to time pieces of the stone facing, which is only from 6 to 12 inches in thickness, split off and fly into the interior of the church.

The dome of St. Paul's consists actually of three domes, an inner dome, (3) of masonry, an intermediate cone, (2) of brick, which carries the weight (800 tons) of the stone lantern, and an external dome of wood covered with lead. At the point (4), where the two domes and the cone meet, Wren imbedded in the masonry some massive chains sealed up in lead, with a view to taking the lateral thrust and insuring that only vertical loads should pass down through the inner drum (10). This drum contains a series of clerestory windows which serve to light the interior of the dome. The wall is four feet thick and the weight of this great drum and the domes is carried upon the eight arches, which transfer the load, as we have noticed, down to the inner edges of the piers, 9, 9, 9. For architectural effect, Wren erected an outer drum, solid in its lower half and its upper half consisting of a handsome peristyle. This peristyle structure, which is very heavy in itself, rests on the center of the width of the eight arches above mentioned.



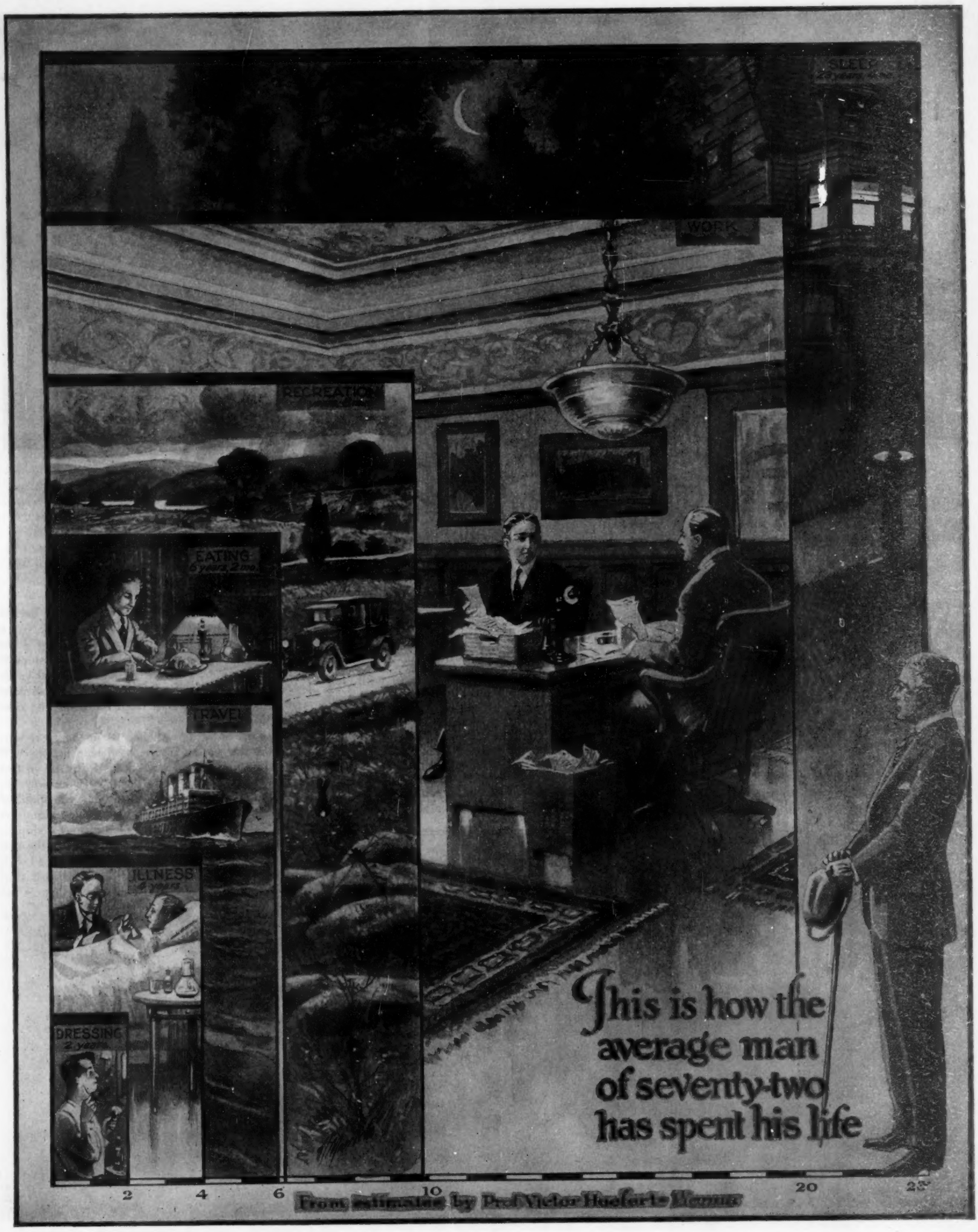
GLOUCESTER CATHEDRAL

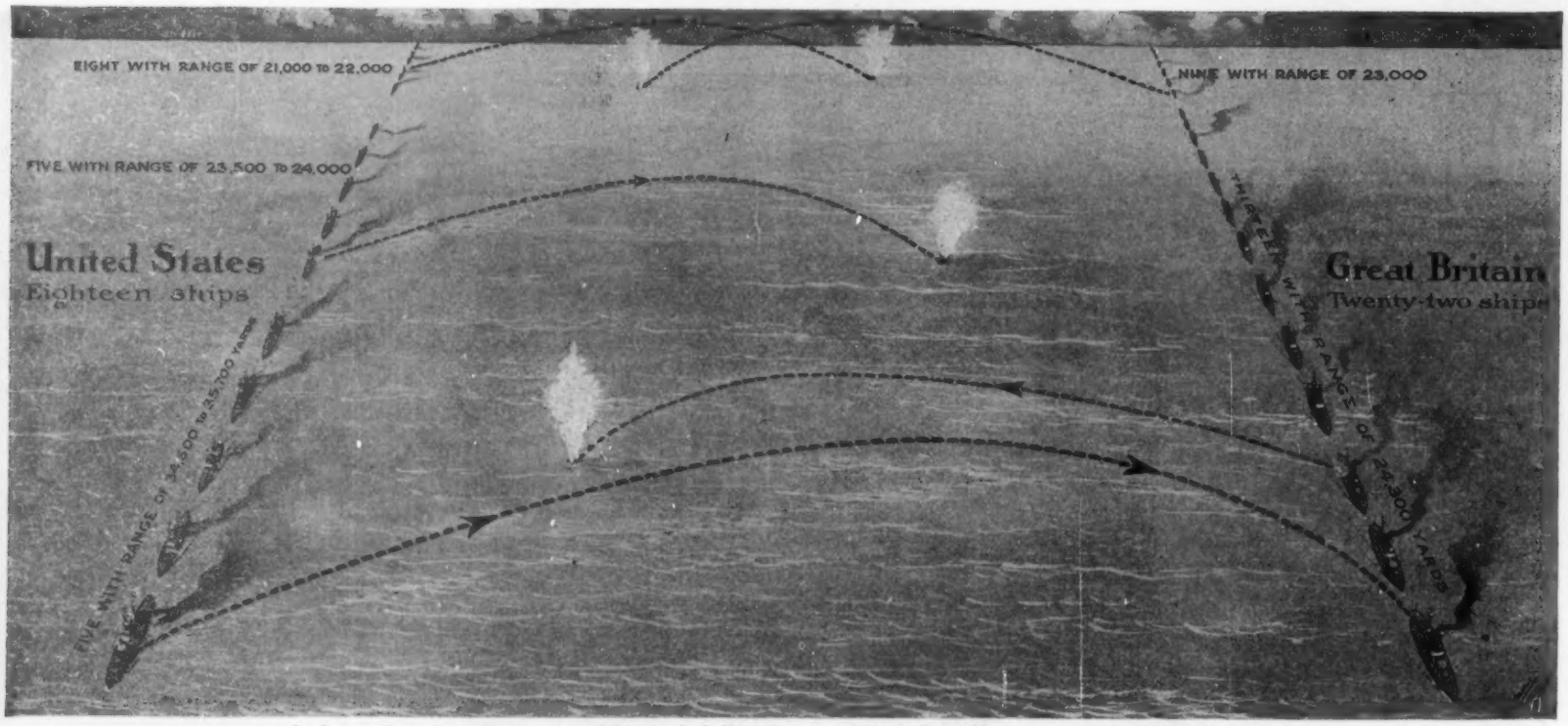
The central tower began to settle and thrust the transept walls out of the perpendicular, so the monks built a series of interior and exterior diagonal stone supports. This one crosses the entrance to a chapel

Distributing the Load

Wren was perfectly well aware of the concentration of load upon the inner edges of his piers, and he endeavored to distribute it over the whole 30-foot depth of the piers by building 32 massive stone buttresses marked "A," which extend from the crown of the several arches and the tops of the piers up to the outer drum, and, by means of intermediate walls between the two drums, connect with the main internal drum at (10). This was good construction; but the subsidence of the inner face of the piers under their eccentric loading caused the inner drum wall to shear away from these buttresses at their point of conjunction with the drum. It seems to us that for future security it is absolutely necessary to relieve the inner faces of the piers of some of their excessive load. This could be done by removing the stone buttresses and putting in their place diagonal steel columns, footing upon steel bedplates, and putting them under stress by means of toggles, such as those used by Fowler at the Niagara bridge. If all the struts were put under equal stress *simultaneously* it would be possible to transfer several thousand tons of the weight of the dome to the outer portion of the arches and piers and relieve the inner face of the arches and piers proportionately.

The report of the Committee of engineers and architects based upon three and a half years examination, which has just appeared, is reassuring. It states that the building can be made secure by grouting, and that all settlement of the foundations has ceased. We do not agree with many of the findings for reasons which are given in our editorial columns.


SLEEP
WORK
RECREATION
EATING
6 years, 2 mo.
TRAVEL
ILLNESS
8 years
DRESSING
2 years
This is how the average man of seventy-two has spent his life
2
4
6
10
20
25
From estimates by Prof Victor Hoefer in Hygeia



At the opening of an engagement and for nearly half an hour our "big five" would outrange the British by five miles

Last Word on the 5-5-3 Ratio

House Naval Committee Decides that Our Battleship Fleet Is Up to Standard

By J. Bernard Walker

WE have before us a copy of the recent hearing before a Sub-committee of the House Committee on Appropriations—a volume of 1,000 pages—which contains the most complete data on the Navy that we have ever seen in a document of this character. The Secretary of the Navy and the officers at the heads of departments were subjected to a very searching examination, particularly as to the status of our treaty battleship fleet, and the public is now put in possession of the facts.

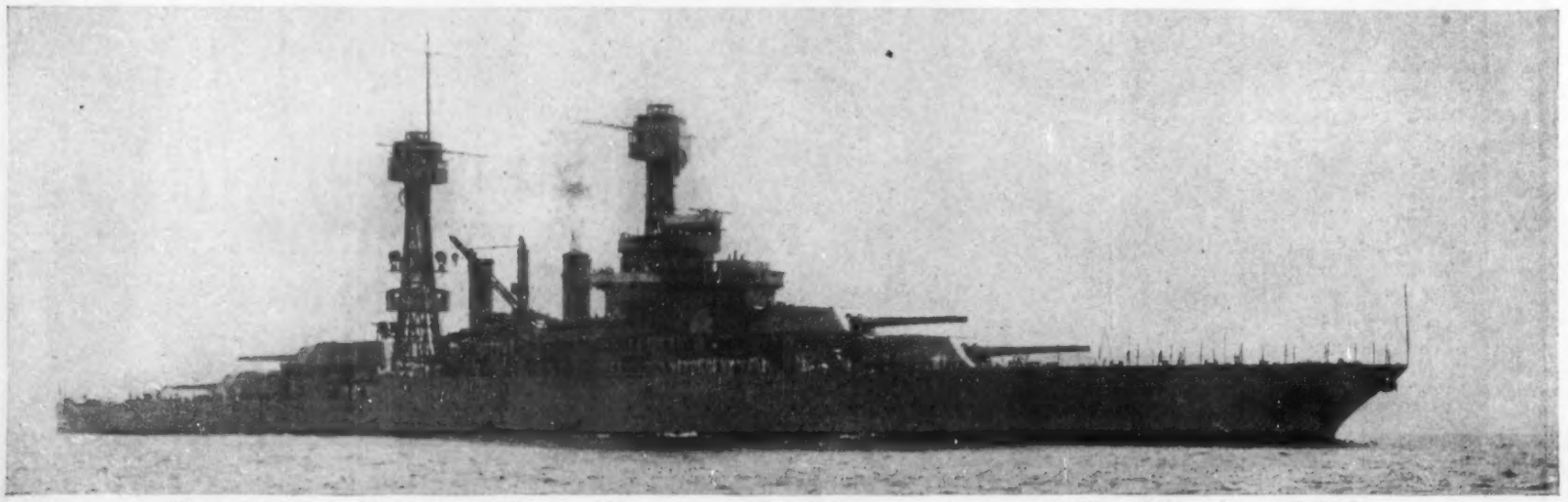
The hearing constitutes a complete refutation of the propaganda of the past few years, which sought to persuade the American public that our battleship fleet was far below the standing of five in the Treaty allocation of 5-5-3 to the United States, Great Britain and Japan. The most startling disclosure is that of the enormous range of the guns of the 32,600-ton battleships which would lead our fleet into battle.

Secretary Wilbur Before the House Naval Committee:

"I have absolutely no sympathy with the claim that we were outgeneraled in that limitation of armaments treaty. The fact is that we got exactly what we proposed, and I am perfectly willing to accept the judgment of those who participated in that treaty that the battleship strength, at the conclusion of the treaty and of the scrapping, was substantially in the ratio stated in the treaty."

These ranges are from 34,500 yards to 35,700 yards. So far as we know, this is the first time these figures have been made public, and they constitute a knock-out blow to those who have claimed that our fleet is outranged and outspeeded by any other fleet. As a matter of fact, the "boot is on the other leg"; for the extreme range of the latest British battleships is only 24,300 yards, or from 10,000 to 11,000 yards less than that of our leading ships. The enormous significance of this is seen from the following considerations.

It is universally agreed that, as in the great war, so in any war of the future, battleship actions will be fought with the respective fleets drawn up in two parallel lines, or, as it is technically known, "in column." No matter how high may be the speed of individual ships, the speed of the whole column as such will be governed by that of the slowest ship in the fleet. This speed is about the same in the two fleets, the slowest American ship being credited with a speed of 20.5 knots and the slowest British ship with a speed of 21 knots. It is probable that, in the



Maryland and class. Displacement, 32,600 tons; Main armament, eight 16-inch guns; maximum range, 34,500 to 35,700 yards; speed 21.3 knots

CAPITAL SHIPS OF THE UNITED STATES

Name of Ship	Turret Guns: Diameter of Bore in Inches	Turret Guns: Length in Calibers	Maximum Angle of Elevation in Degrees	Range in Yards	Speed in Knots	Displacement in Tons
West Virginia	16	45	30	34,500	21.2	32,600
Colorado	16	45	30	34,500	21.4	32,600
Maryland	16	45	30	34,500	21.1	32,600
California	14	50	30	35,500	21.7	32,300
Tennessee	14	50	30	35,700	21.4	32,300
Idaho	14	50	15	24,000	21.3	32,000
New Mexico	14	50	15	24,000	21.1	32,000
Mississippi	14	50	15	24,000	21.1	32,000
Arkansas	12	50	15	24,350	21.1	26,000
Wyoming	12	50	15	23,500	21.2	26,000
Arizona	14	45	15	21,000	21.0	31,400
Pennsylvania	14	45	15	21,000	21.1	31,400
Oklahoma	14	45	15	21,000	20.6	27,500
Nevada	14	45	15	21,000	20.5	27,500
New York	14	45	15	21,000	21.5	27,000
Texas	14	45	15	21,000	21.0	27,000
Florida	12	45	15	22,000	22.1	21,825
Utah	12	45	15	21,600	21.0	21,825
Grand Total						525,850

unlikely event of a naval battle between us and the British, the two fleets would settle down to a speed of about 20 knots. The British line includes five 25-knot ships and four battle cruisers credited with speeds of 29 to 31.5 knots. Whatever might happen during the approach of the two fleets, it is certain that when they fell into line for the great test, these faster vessels would have to hold their speeds down to the fleet fighting speed of 20 knots.

If the weather is clear, and we will suppose it is, and if airplane and general scouting information has been ample and correct, the two fleets will deploy into column before they come within range. Thereafter they will approach each other on more or less converging courses. Now let us see what would happen. The head of the British line, containing their latest ships of the Royal Sovereign class, would come under the fire of the head of our line at a distance of over 17½ miles, or at a distance where their own 15-inch guns, firing at maximum elevation, would drop their shells 10 to 11,000 yards, or 5 to 5½ miles, short of the American line. They would not dare to come in end-on, because in that position they would be raked by our salvos, and in spite of the dispersion of the falling shells, a single eight-gun salvo might drop from three to half-a-dozen shells upon the deck of any ship thus approaching. Hence, the approach would be made on a converging course, and instead of 15 minutes it would take some 25 minutes or more for the British to get within range. During all that time they would be exposed to heavy shell fire of a most devastating character to which they could make no reply. With our system of fire control, and assuming airplane spotting to be possible, it would be possible to drop between 1,000 and 1,200 shells upon the leading ships of the British line before they could get in close enough to return our fire.

It is surely no exaggeration to say that, under existing circumstances, if our fleet were able to maintain airplane spotting, the head of the British line would be crumpled up and either severely crippled or put entirely out of the fight before it could get within hitting range.

As the fleets continued to close in, the British with a range of 24,300 yards, and the next five of our ships with from 23,500 to 24,000 yards, would engage each other. At this time our eight older ships with 21,000 to 22,000 yards range would be outranged by the opposing British ships by from 1,800 yards to 2,800 yards. Our own line, of course, would close in until these older ships could reach the enemy; but for several minutes the tail end of the British line would have the advantage of ours. But this temporary advantage of the enemy over our older ships, which would last for four to six minutes, would not compensate for the fact that for 25 minutes at the commencement of the action the best ships of the British line had been subjected to an overwhelming gun fire to which they could make no reply.

The British line would include four battle cruisers, of which the Hood alone, with guns of 30,300 yards range and 12-inch armor, could stand up to the fire of the 14-inch and 12-inch guns of our older ships. The other three, Renown, Repulse and Tiger, with only 9-inch armor, would probably share the fate of the three battle cruisers that were sunk by 11-inch and 12-inch gun fire early in the battle of Jutland.

It is for these reasons we are satisfied that the American public, on looking at these two tables and the sketch prepared by our artist showing the approach of the two fleets, will agree with us that, far from our fleet being outranged, and outspeeded, we ourselves have the whiphand, and with equal gunnery and equal seamanship could very reasonably count upon a sweeping victory.

And let it be clearly understood that if the proposed elevation of all the guns of our fleet to 30 degrees were followed out, not merely our "big five" but our whole fleet of 18 ships would have the enemy under fire for from 15 up to 25 minutes before he could reach us. Such a change would vitiate the nice balance which was determined upon between our officers and those of the British in the selection of the respective battleship fleets, and would place us at an enormous fighting advantage.

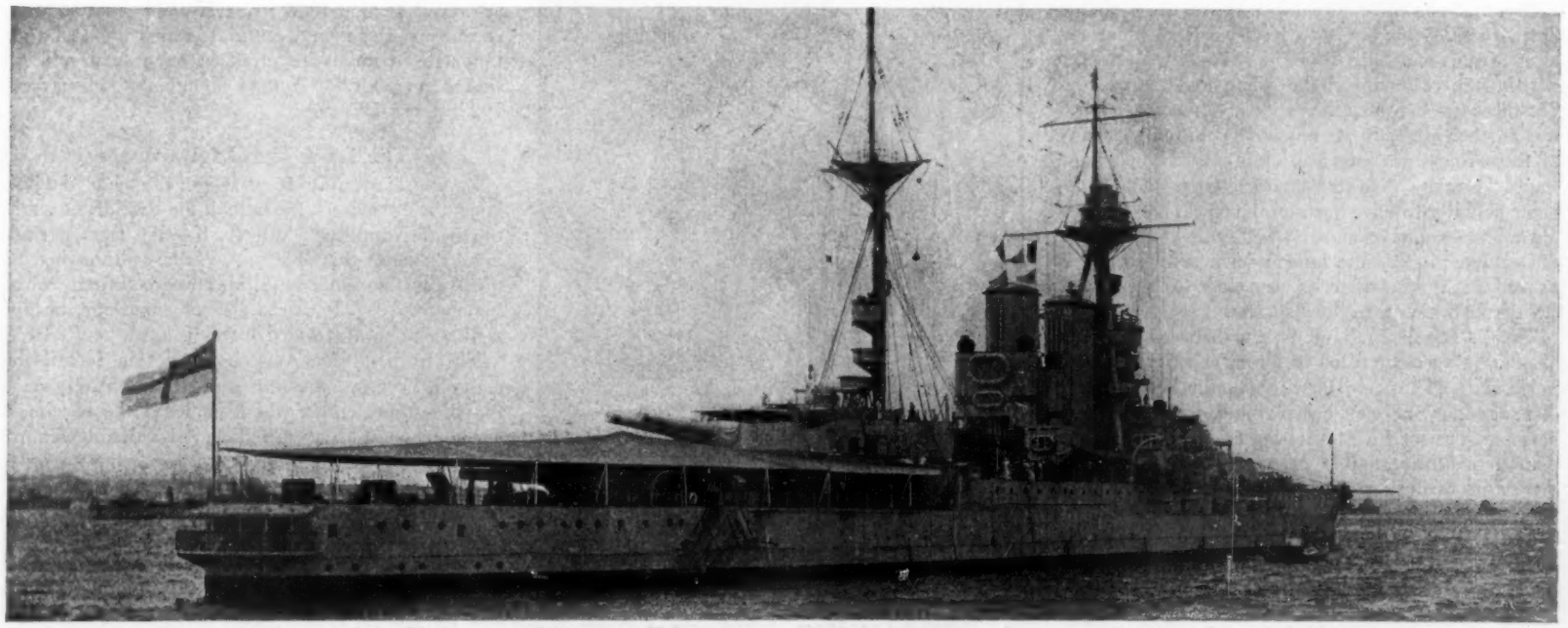
It was brought out at the hearing that, with the exception of the Florida, the boilers of the ships which had to reduce their speed in the Panama maneuvers had been repaired and that these ships can now make their trial speeds. The Florida is in port for similar repairs.

In conclusion, there are two duties which confront the United States—first, to grant, without any reduction, the appropriations asked by the Navy Department for repair work; and secondly, to bring our fleet up to Treaty strength in unarmed cruisers, fast scouts, airplane carriers and such vessels as are not limited by Treaty.

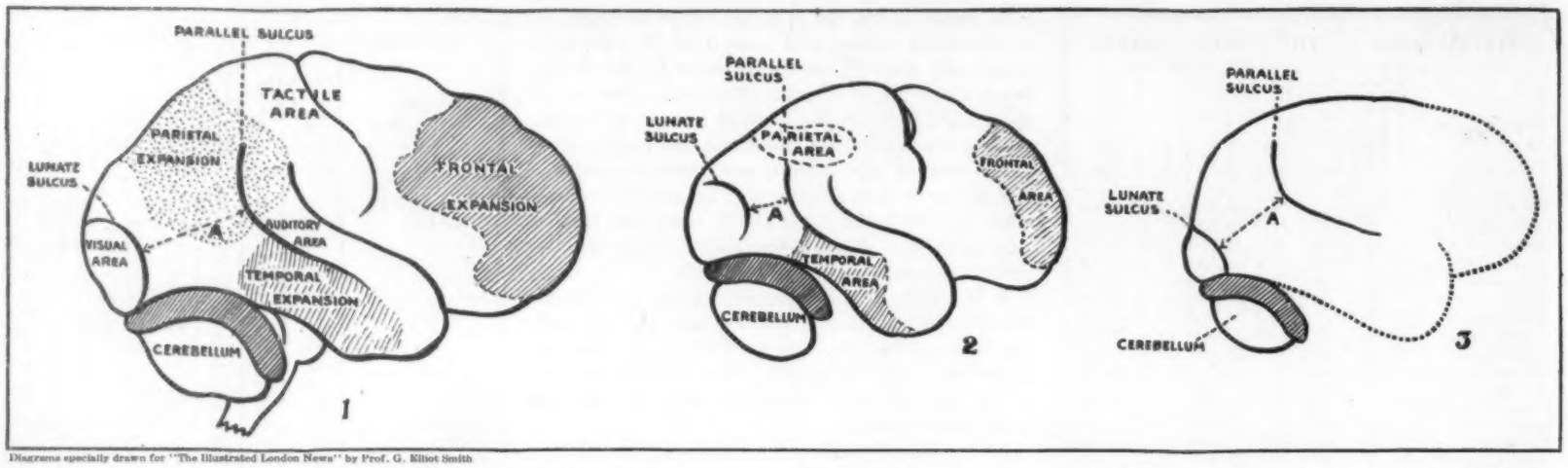
CAPITAL SHIPS OF THE BRITISH NAVY

Name of Ship	Turret Guns: Diameter of Bore in Inches	Turret Guns: Length in Calibers	Maximum Angle of Elevation in Degrees	Range in Yards	Speed in Knots	Displacement in Tons
Royal Sovereign	15	42	20	24,300	21.6	25,750
Royal Oak	15	42	20	24,300	21.5	25,750
Revenge	15	42	20	24,300	21.9	25,750
Resolution	15	42	20	24,300	21.6	25,750
Ramilies	15	42	20	24,300	21.5	25,750
Malaya	15	42	20	24,300	25.0	27,500
Valiant	15	42	20	24,300	25.6	27,500
Barham	15	42	20	24,300	25.0	27,500
Queen Elizabeth	15	42	20	24,300	25.0	27,500
Warspite	15	42	20	24,300	25.0	27,500
Hood	15	42	30	30,300	31.5	41,200
Renown	15	42	20	24,300	31.5	26,500
Repulse	15	42	20	24,300	31.0	26,500
Tiger	13.5	45	20	23,800	29.0	28,500
Benbow	13.5	45	20	23,800	21.5	25,000
Emperor of India	13.5	45	20	23,800	21.5	25,000
Iron Duke	13.5	45	20	23,800	21.6	25,000
Marlborough	13.5	45	20	23,800	21.6	25,000
Thunderer	13.5	45	20	23,800	21.	*22,500
King George	13.5	45	20	23,800	21.4	*23,000
Ajax	13.5	45	20	23,800	21.1	*23,000
Centurion	13.5	45	20	23,800	21.9	*23,000
Grand Total						580,450

*These four to be scrapped when Nelson and Rodney are completed, when total will be 558,950, against United States 525,850; the extra tonnage allowed to offset greater age of British Fleet.



Royal Sovereign and class. Displacement, 25,750 tons; Main armament, eight 15-inch guns; maximum range, 24,300 yards; speed, 21.6 knots



Diagrams specially drawn for "The Illustrated London News" by Prof. G. Elliot Smith

1 is a diagram of an exceptionally small ape-like brain of an African negress; 2 is the brain of a large gorilla; 3 is the brain of the recently discovered baby man-ape described in this article. Note the expansion of that part of the brain called the parietal area, the part believed to be the seat of associative memory—the faculty of profiting by experience.

Did Man Evolve in Africa?

An Account of the Remarkable Fossil Man-Ape Recently Discovered in Africa by Professor Dart

By Albert G. Ingalls

Associate Editor of the Scientific American

ANOTHER brilliant fossil find has just been added to the steadily growing group of man's racial ancestors and relatives. In semi-desert Bechuanaland, South Africa, just across the western border of the Transvaal and eighty miles north of diamond-famed Kimberley, there has just been found the almost perfect fossil skull and jawbone of an extinct creature described by its sponsor, Professor Raymond A. Dart of the Witwatersrand University, as intermediate in type between the living anthropoid apes and man.

The new fossil has been named *Australopithecus africanus*, or "South African ape," but it will probably come to be known also under the designation of the Taungs skull, from the name of the community near which the remarkable fossil was discovered.

Where is this new find to be placed in the family tree of man and his ape cousins? What is its broader significance?

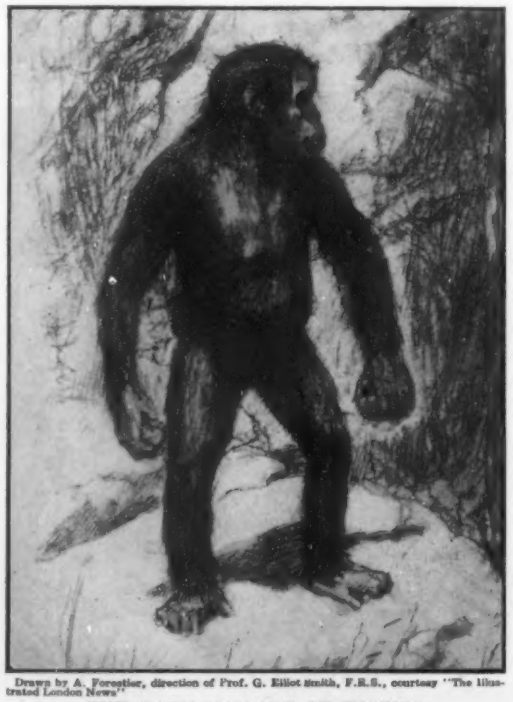
An Ape Well Along Toward Man

It is too soon to be sure, but it is already probable that *Australopithecus* is to be regarded as not far away from the four living anthropoid apes; the gorilla, the chimpanzee, the orang and the gibbon. But there are certain reservations. *Australopithecus* was further along in its upward evolution than any of these four apes now are. Moreover the new ape shows so many man-like characteristics that it appears actually to have been on the track, so to speak, towards the status of man. Whether its kind actually did evolve, finally, into human form is by no means proved, but it appears to be very close to that animal stem from which man later sprang.

Thus is another part of the gap between man and his simian ancestor filled in by an additional "missing link." Thus is Darwin's prediction that the direct ancestor of man, when found, would prove to be some form of forest-dwelling ape, tied up tighter than ever with tangible evidence. Thus does the theory of evolution, as applied to the descent of man, receive another and a weighty vindication.

The geologic age of the Taungs skull is not yet entirely certain. The creature to whom it belonged is certainly older in the scale of evolution than the Trinil race of Java, the famous *Pithecanthropus erectus* or "walking ape-man" (not man-ape) who lived about half a million years ago. On the other hand it must be more recent than the group of extinct anthropoid apes which includes the two genera, *Dryopithecus* and *Sivapithecus*, which many anthropologists believe stand close to the central stem from which both man and the modern apes arose. Probably the best estimate for *Australopithecus* would place it sometime during the middle part of the Tertiary Period of the geologists, probably either in the late Miocene Epoch or in the early Pliocene Epoch. This would be, on a conservative estimate, at least two or three million years ago.

The skull was found embedded in limestone at a depth of fifty feet below the surface. This depth, however, means little, as it would appear that this particular specimen of *Australopithecus*—he was a baby, scarcely more than four years old, if that—either had lived in a cave in this limestone formation or met his death there. In the course of ages the cave slowly filled up with stalagmites. The skull was encased in these stalagmites and turned to solid rock. Modern quarrymen blasted it out of the rock. It came into the hands of Professor Dart. Protruding from one side of the piece of rock he saw what looked like a jaw bone. The solid limestone surrounding the skull was then carefully picked away, when the entire face came to light.



Drawn by A. Forestier, direction of Prof. G. Elliot Smith, F.R.S., courtesy "The Illustrated London News"

THE BABY MAN-APE OF TAUNGS

Though not yet human, Australopithecus *already walked erect*

So nearly complete is the specimen that the usual arguments concerning its proper reconstruction should not arise. Moreover, some of the world's foremost anthropologists have stated that no one is more competent than Professor Dart to observe the evidence and interpret it. "It was a happy circumstance," says Professor G. Elliot Smith, Professor of Anatomy in the University of London, "that such a specimen fell into his hands, because he is one of the, at most, three or four men in the world who have had experience in investigating such material and appreciating its real meaning." (*Illustrated London News*, February 14, 1925.)

Professor Dart makes the summary statement concerning the new fossil that "it is a creature well advanced beyond modern anthropoids in just those characters, facial and cerebral, which are to be anticipated in an extinct link between man and his simian ancestor." (*Nature* (London), February 7, 1925, pages 195-199.)

The Teeth Are of Importance

In several separate respects—in the teeth, the jawbone, the eyesockets, the hole at the base of the skull, the brain, and the skull itself—the Taungs skull gives evidence that *Australopithecus*, although technically but an anthropoid ape, was definitely evolving manward. He was a sort of super-ape, an ape well on the way toward man's estate.

The teeth, always very important in identifying a fossil, have not yet been worked out entirely from the limestone matrix which enclosed the specimen. Their crowns, which are the most valuable feature for determining the relation of the genus to other apes, have not yet been exposed. It can be said, however, that the teeth are distinctly man-like. For example, the incisors are irregular in size, they slightly overlap, and they are almost vertical—all as in man. By contrast with this hominoid character the teeth of all living anthropoid apes project forward, as do the jaws, the chin sloping backward.

It is the teeth, by the way, which fix the age of the Taungs specimen as a baby, his first permanent molars being just in course of emergence.

The ramus, or the forked, vertical portion of the lower jawbone just below the ear, is more massive than that of a human of the same age, but it is narrower than that of the four anthropoids. The front part of the lower jawbone (the chinbone) is nearly as vertical as is that of the fossil Heidelberg man of Europe. This is another strong evidence that *Australopithecus* was definitely departing from the anthropoid ape stage.

No Longer Fought With Teeth

It tends to indicate, indeed, that he had already assumed an erect posture, for when the erect position frees the hands for defense and offense the teeth are no longer needed for fighting, and in the course of generations they gradually become vertical. The chinbone moves outward.

Additional evidence that *Australopithecus* had already assumed a more erect posture than that of the anthropoid apes is found in the position of the large, round hole, or foramen magnum, in the under part of the skull, the hole which provides a passage for the spinal canal. In the apes this opening is comparatively close to the rear of the skull. In man it is placed much farther forward, so that the skull of man balances on the spine. In the Taungs skull the position of the foramen magnum approaches that of man.

The eye-sockets, instead of being rather four-sided are almost circular. The brain cavity of the Taungs specimen has a volume of 450 cubic centimeters, but it is a baby brain and the experience of anthropologists indicates that had this infant ape been allowed to grow to adult size the Taungs specimen would have had a brain volume of about 520 cubic centimeters. This volume exceeds the volume of the average gorilla brain by about fifty cubic centimeters.

Highly significant, as indicating that *Australopithecus* had departed from ape status in the direction of man's status is the shape of the skull and the face. All anthropoids have skulls that, viewed from above, would be round, while the faces are broad. The Taungs skull shows us the first long-skulled, long-faced anthropoid.

The way in which the skull was preserved provided, by good fortune, not only the skull itself, but a cast of the brain, one part of the brain cavity having been left open in the fossil. This brain, as well as the skull, clearly indicates that *Australopithecus*, even in this four-year-old baby, had more intelligence than any of the living anthropoids. When the cross-section of the central or parietal part of the brain of the Taungs specimen is superimposed on that of the gorilla we find that it is very much higher, although not so broad. In fact, the most significant feature of the Taungs brain is the remarkable development of its parietal area. Says Professor Dart, referring to the expansion of this area, "It indicates (together with the narrow interorbital interval and human characters of the orbit) the fact that this group of beings, having acquired the faculty of stereoscopic vision, had profited beyond living anthropoids by setting aside a relatively much larger area of the cerebral cortex to serve as a storehouse of information concerning their objective environment as its details were simultaneously revealed to the senses of vision and touch, and also of hearing. They possessed to a degree unappreciated by living anthropoids the use of their hands and ears and the consequent faculty of associating with the color, form, and general appearance of objects, their weight, texture, resilience and flexibility, as well as the significance of sounds."

They Were on the Way to Speech

"In other words, their eyes saw, their ears heard, and their hands handled objects with greater meaning and to fuller purpose than the corresponding organs in recent apes.

"They had laid down the foundations of that discriminative knowledge of the appearance, feeling, and sound of things that was a necessary milestone in the acquisition of articulate speech."

Why did *Australopithecus* attain millions of years ago a higher stage of evolution than the living anthropoid apes have reached now? Quite likely it was owing to the climate in which he lived. There is evidence, says Professor Dart, that the climate of Bechuanaland has not changed greatly since the beginning of the Age of Mammals. Desert, semi-desert, veldt, plains, or savannah country—all are favorable to rapid evolution. On the other hand, animals which remain in forest country have little urge to evolve. Life is too easy there. But in deserts food is scarce. Larger beasts of prey must be avoided. All this quickens the brain.

Darwin, writing in *The Descent of Man*, said (Part 1, Chapter 4), "It is somewhat more probable that our early progenitors lived on the African continent than elsewhere." A few living anthropologists concur in Darwin's belief. The majority have believed, however, that man evolved from his ape ancestor in or near Central Asia.

Did Desert Drive Apes to Evolve?

There arises, then, the interesting question whether the new discovery of a man-like ape, one which was definitely committed, so to speak, towards a manward course, actually proves that man did evolve in Africa. It does not prove it; in fact some would assert that it carries little weight, since there has been ample time in the millions of years since the time of *Australopithecus* for the dispersal of an active animal several times around the world.

But, nevertheless, the discovery of a man-ape in the same continent with its most closely related living anthropoids, the chimpanzee and gorilla, does fit in well with a theory of how and why certain groups of ancient apes have remained apes to this day, while others have evolved upward into man.

Suppose that anthropoid apes of the same kind reached Africa and divided into two groups. One group finds its way to what is now tropical, forested Africa. The other goes to South Africa, or to some nearby region which slowly becomes more arid. The group which remains in the tropical forest where food is easily obtained evolves but little. On the other hand the group which dwells in the arid region would either be exterminated by the new and increasingly adverse conditions of dryness and dwindling forests or it would adapt itself to the changing environment, and in so doing, it would evolve.

In dry or desert country the struggle for existence is hard. To get food, wandering is necessary. Competition for the little food that is available there is keen. Such conditions furnish the evolutionary urge. The essential difference between man and his monkey-ape ancestors is the great superiority of man's brain. Perhaps he got this because in Africa or elsewhere he had to struggle against bitter odds.

"Wide World"

THE SKULL AND ITS DISCOVERER

Professor Dart, with the famous fossil in his hand. A front view of this skull was printed in the Scientific American for April, 1925.

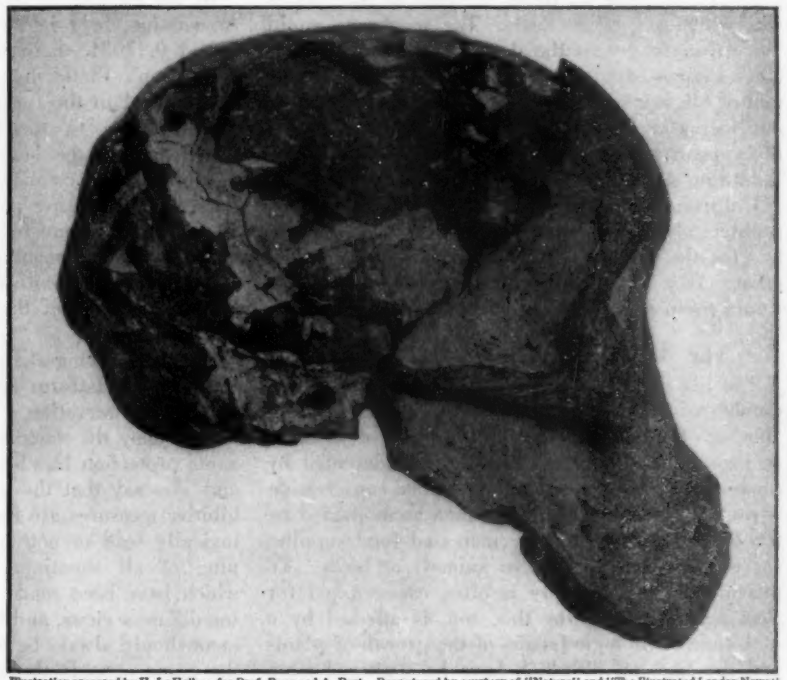


Illustration prepared by H. Le Helloco for Prof. Raymond A. Dart. Reproduced by courtesy of "Nature" and "The Illustrated London News"

A SIDE VIEW OF THE FAMOUS SKULL

Although the skull is partly broken, its important crestline is intact, permitting accurate reconstruction. The teeth are in perfect condition

Courtesy of the California Academy of Science

A Policy for the Conservation of Our Wild Game

A HUNDRED years ago the forests and prairies of North America teemed with millions of wild birds and animals. The disappearance of that unexampled collection of wild game was to be expected and was necessary. An industrial country cannot be, at the same time, a hunter's paradise. Nevertheless, it will be a pity if *all* our wild game is allowed to vanish. The naturalist desires, quite properly, to preserve living samples of the species with which his science deals. The sportsman would not willingly permit the destruction of one of his chief sources of sport. And, probably most important of all, it is not desirable that we take away from our increasingly city-bound population one of the main incentives to open-air interludes in tent or saddle or canoe.

Unfortunately, it is too seldom realized that this problem of game conservation is, at bottom, a problem for the scientist. It is true that sportsmen kill game. It is not true that prohibition of sportsmen would mean an indefinite increase in game.

The American Sportmen's Platform

The life of any animal species depends on a vast number of natural factors, the chief of which, probably, are food and disease. Prohibition of shooting or excessive lowering of bag limits—advocated by some extremists as a measure for game conservation—would accomplish nothing unless accompanied by the provision of sufficiently increased food supplies for the expected increase in animals or birds. To provide this food supply is often easier asked for than accomplished; for this, too, is affected by a multitude of biologic factors of the growth of plants and the like, all of which have been altered more or less completely from their natural conditions as a result of the industrial and agricultural growth of the country. The problem of controlling disease is an even more complicated and difficult one.

What, then, is the remedy? How is the remaining game of the country to be saved?

The answer lies in scientific study. The life histories, the feeding habits, the natural needs and dangers of game creatures must be studied by competent biologists. Regulatory measures must be designed in the light of such information and must be enforced rigidly.

At the meeting of the American Game Protective Association, held in New York City on December 8 and 9, 1924, there was adopted the "American Sportsmen's Platform," which calls for this scientific control in the following words:

"Utilization to the fullest extent of scientific knowledge for the increase of birds, animals, fish and forests, for combating disease and natural enemies, for preventing pollution, for providing food on barren areas and for propagation and stocking.

"The encouragement of schools for training specialists and of scientific investigation leading to a better knowledge of the life histories and status of fish and game."

After approving the policy of establishing game refuges the Platform goes ahead to define a policy of game conservation.

"We deny the statements of those who affirm that game protection has been a failure in this country and who say that the game is doomed unless prohibitive measures are increased. Such a policy can logically lead to nothing except the eventual stopping of all shooting. We deprecate the attacks which have been made upon conservationists holding different views, and we affirm that while retrenchment should always be made when the demand upon the game exceeds the supply, to extol this minor administrative practice as a panacea of major importance is suicidal. Not solely by dependence upon arbitrarily and progressively cutting the seasons and bag limits, but by constructive methods can our game supply be increased.

"Attention is called to the fact that in this country under our present system of game protection by constructive administration no game animals or birds or fish have been exterminated and none will be exterminated. The loss of the passenger pigeon and buffalo was due to commercialism. Where game has disappeared locally and suitable habitat still remains, the cause will be found to be in neglect of well recognized principles of conservation.

Game Cannot Be Stored Like Gold

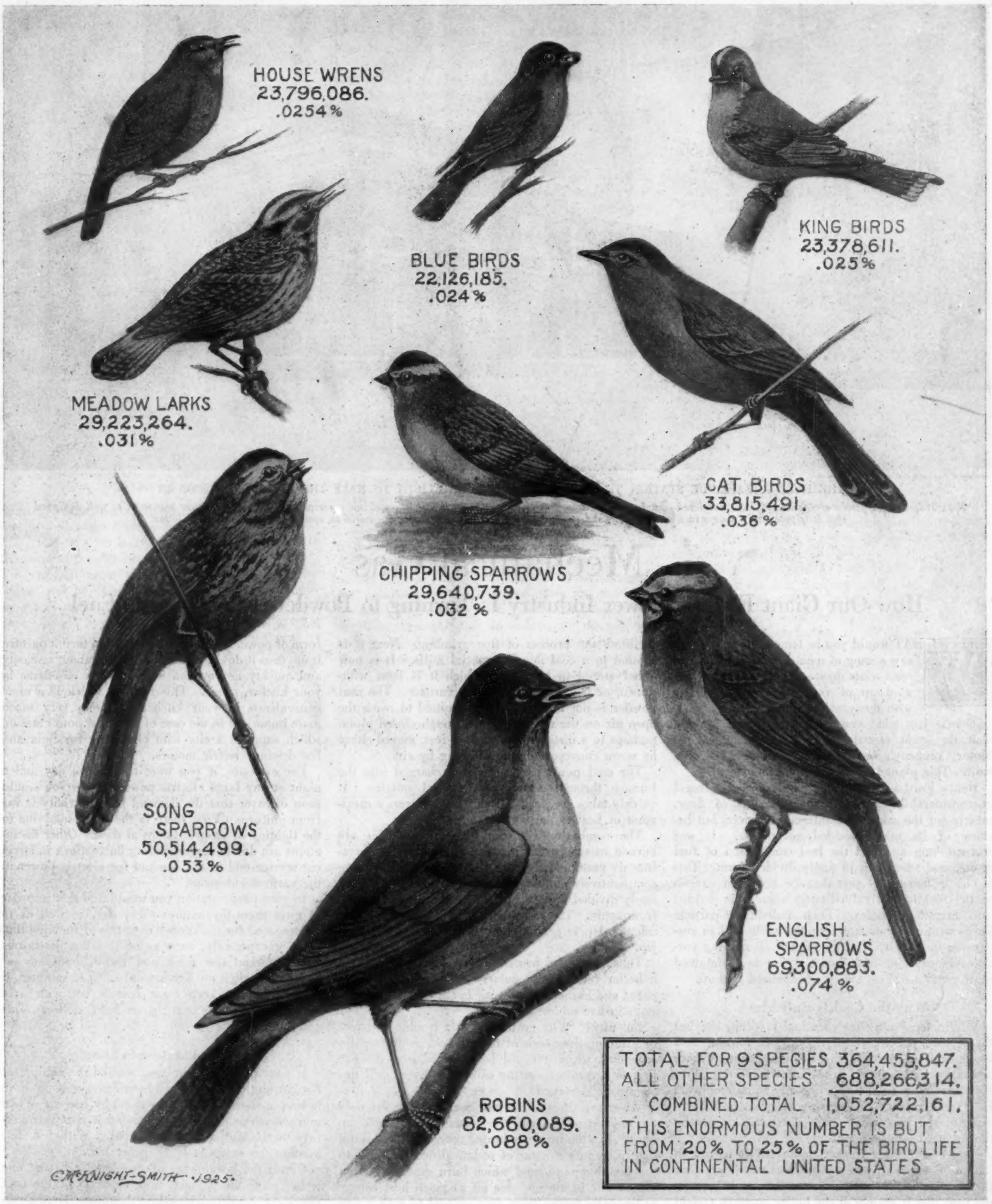
"Conservation consists of consuming only the excess, of keeping the principal intact and enjoying the interest. Those who demand prohibition of such enjoyment are giving counsel of miserliness. Game cannot be stored like gold; it must live, and to live it must be fed. There is the essence of the problem: How much game can we feed?

"The maximum benefit for all lies in producing all the game we can. This is constructive administration. Then let us consume no more than the yearly increase. That is conservative administration.

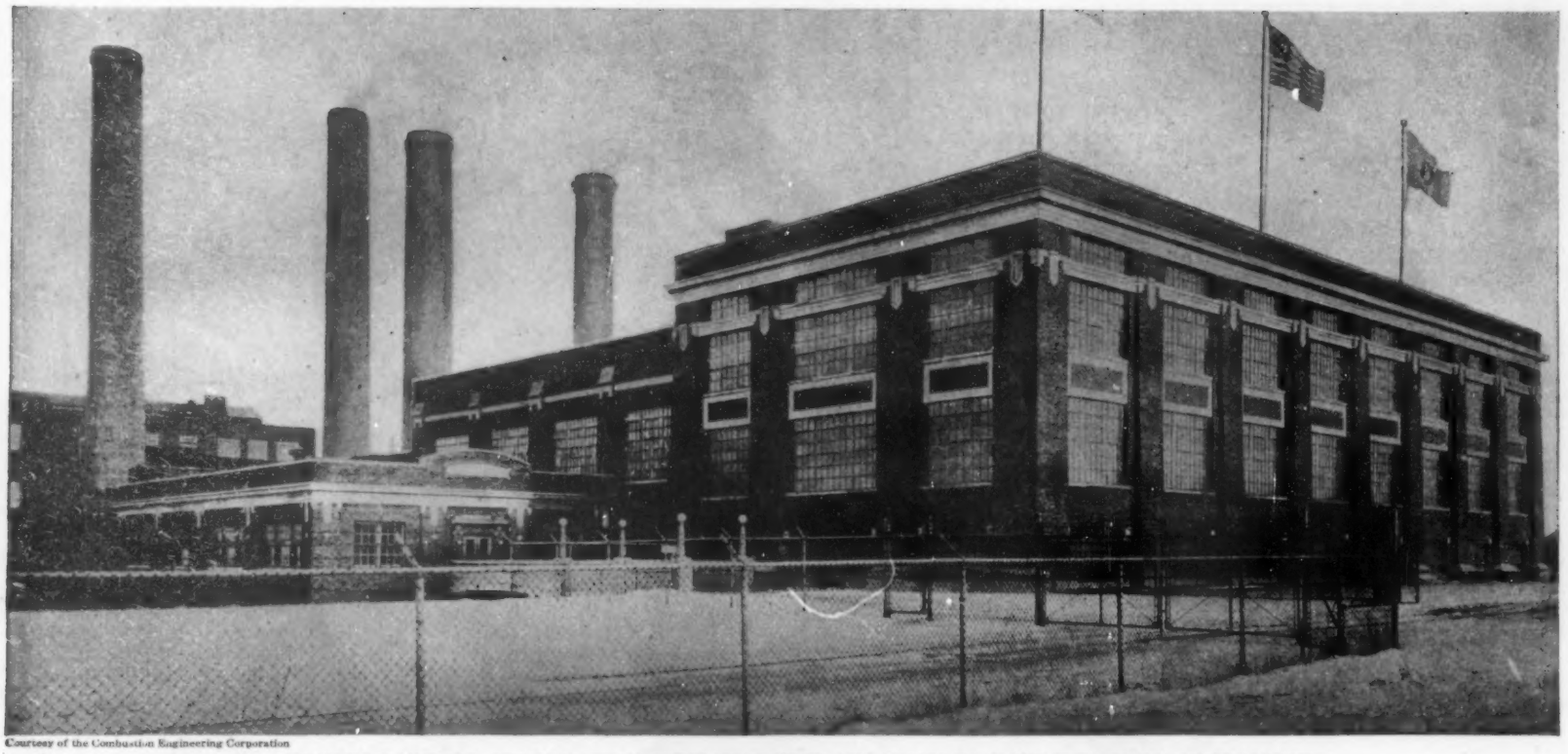
"The two processes constitute constructive conservation, which is purely a biological and economic problem into the solution of which mere sentiment does not enter. It is a problem for trained specialists, who must be furnished with funds to meet expenses, with authority to enforce their findings, and who must be permitted a certain range of discretion to compensate for varying conditions.

"The facts are plain; once game administration is put upon a proper basis there need be no alarm for the future of the game supply."

These are sentiments which the Scientific American wishes heartily to endorse. Scientist and sportsman must work earnestly together to solve the problems of conserving our supply of game.



The figures on this drawing represent the results of a bird census of the Northeastern and Central States, as reported by the Bureau of the Biological Survey of the United States Department of Agriculture. Their estimate shows a total of approximately two hundred and twenty-four birds per hundred acres. On this basis the total bird population of the world is probably over seventy-five billion, some forty times the number of human beings.



Courtesy of the Combustion Engineering Corporation

THE FAMOUS LAKESIDE STATION THAT SUPPLIES POWER AND LIGHT TO HALF THE STATE OF WISCONSIN

Here 175,000 horsepower are generated from powdered coal having the low heat value of 12,000 British thermal units per pound. This great power station is so well equipped that it is practically always in a state of test, and engineers have come from all over the world to study its remarkable installation

Mechanical Gas

How Our Giant Electric Power Industry Is Turning to Powdered Coal for Its Fuel

WHAT would you be tempted to say if you saw a gang of men dressed in spick and span white duck suits, engaged in firing a group of very large steam boilers with dusty soft coal?

This is just what you would see if you were to visit the great electric power plant at the Ford Motor Company's factory at River Rouge, near Detroit. This plant is fired with powdered coal.

Henry Ford is not burning coal powder, ground at considerable expense to the fineness of flour, merely for the sake of cleanliness, however, but because of its many decided advantages. It was learned long ago that the best combustion of fuel is obtained when it is in finely divided form. This is chiefly due to the fact that the access of oxygen to the fuel is vastly facilitated when it is divided into minute particles. Each individual particle burns within one or two seconds, while still in suspension in the air. But the stream of arriving particles is constant and thus the fire is maintained much as is a fire of gas or of atomized fuel-oil.

Why the Coal is Pulverized

Within ten years, but principally within the last three years, this interesting method of burning fuel has advanced by leaps and bounds. This advance has taken place chiefly in the electric power industry where pulverized fuel is already being employed in a large number of those really great power stations of the type which supply electric energy by the hundred thousand horsepower.

Before going any further, however, let us get an idea of the several processes that the coal or other fuel—sometimes it is lignite—goes through between the time that it arrives at the boiler room in freight cars and the time it is finally burned.

First, the coal is crushed to about the size of a hickory nut. Then it is usually dried in order to facilitate the process of fine grinding. Next it is ground to a coal flour in special mills. It is now either stored in bins from which it is later withdrawn, or it goes directly to the furnace. The coal powder is not in either case permitted to reach the open air on the way. It goes through closed pipes, perhaps to a distance hundreds of feet, moved either by screw conveyors or blown along by air.

The coal powder is steadily discharged into the furnace through a series of special nozzles. It quickly takes fire, burns at once and delivers a maximum of heat to the boiler.

The combustion is complete, the particles are burned in suspension in the air and there is therefore no grate and the ash disposal problem is comcomparatively simple. About one third of the ash, finely divided, goes up the stack and is never heard from again. The rest, in the form of finely divided ash powder, is generally flushed away by means of jets of water.

Thus the entire process is decidedly simple. In a boiler room where pulverized fuel is being prepared and burned the visitor can easily witness every stage in five minutes.

But why? Why go to the extra trouble and cost of grinding thousands of tons of coal to an impalpable dust when it could be shoveled into the fire just as it comes from the cars and just as coal has always been burned?

When you throw a lump of coal on a hot fire only the outside which is in the presence of oxygen can burn. But the inside is heated, nevertheless. Without going into a maze of technicalities it suffices to say that lumps of coal which burn gradually from the outside in, do not give off as much heat energy as the same lumps do if first ground to such a fine powder that each microscopic particle is within practically instant reach of a full supply of oxygen.

Another great advantage of burning fuel in the form of powder is the fact that you can turn it on, turn it up, turn it down, or turn it out just about as easily and quickly as you can manipulate a gas flame in your kitchen range. This feature, which is a mere convenience in your kitchen, becomes very much more important in the case of the great power station which supplies a city with electricity for light and for driving electric motors.

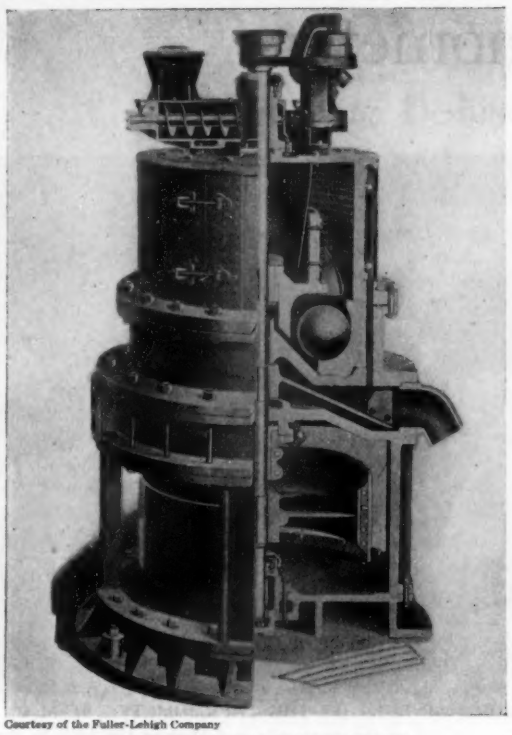
For example, if you were to spend a day and a night at any large electric power station you would soon discover that the demand for electricity is far from uniform. First there is the great load due to the lighting of electric lamps at dusk. Other fluctuations are due to corresponding fluctuations in street car service and in the demand for electric power in the various industries.

In your power station you would find that in order to meet these fluctuations every day, as well as to be prepared for emergency demands of the kind that come unexpectedly, such as sudden thunder-storms which darken the skies and cause thousands of people to switch on lights within fifteen minutes, it is necessary to keep extra boilers hot with fires banked, ready to steam up on brief notice. This costs money.

The Preparation is Simple

If your power station has installed the equipment for burning powdered fuel, however, it will not have to keep a slow fire under the stand-by boilers. When more steam is suddenly demanded it is only necessary to light the powdered coal. Within a few minutes the steam is being generated.

Of all the advantages of powdered coal the one which gives the engineer independence of the coal operators seems to please him the most. If you own a home you know how hard it is to get coal of uniformly good grade from year to year. But the engineer who has charge of a great power plant



Courtesy of the Fuller-Lehigh Company

FINER THAN TALCUM POWDER

In the rotary grinder steel balls reduce the fuel to feathery dust

generally experiences altogether more difficulty of this sort than the home owner.

If, however, he is equipped to burn his coal in the form of powder he discovers that he cannot only use many different grades of coal under the same boiler, but he can also switch from a good grade to a bad grade, from a grade having a high heat value to one having a low heat value, even from a high quality of bituminous coal to brown coal or lignite, within a few minutes without any diminution of steam pressure whatever. If the new coal is poorer he simply accelerates the screw feeder and injects enough more fuel to make up the difference.

In preparing the coal for use as powder it is first passed over a strong magnetic separator. This removes the few pieces of iron that always find their way into large shipments of coal, and thus protects the crushing machinery from harm. After the coal has been crushed to such a size that it can be handled conveniently by the fine grinder it goes, in some cases, to the dryer. Coal always contains moisture in varying amounts, and while the presence of this moisture has no effect on the burning qualities of the fuel, it will cause trouble in the grinding and subsequent handling operations if there is enough of it in the fuel.

Coals from the Appalachian coal fields do not usually contain enough moisture to cause trouble and, therefore, they are seldom dried. Those from the Central and Western coal fields are, however, nearly always dried to some extent.

For the pulverizing of the coal there are two types of mill in use. In the rotary type of mill the lumps of coal are run over by rapidly revolving steel balls which reduce it to the fineness of talcum powder. The other type of grinder is the impact type and consists of a rapidly revolving disc having lugs distributed around its periphery. These lugs strike the coal and reduce it to dust by direct impact.

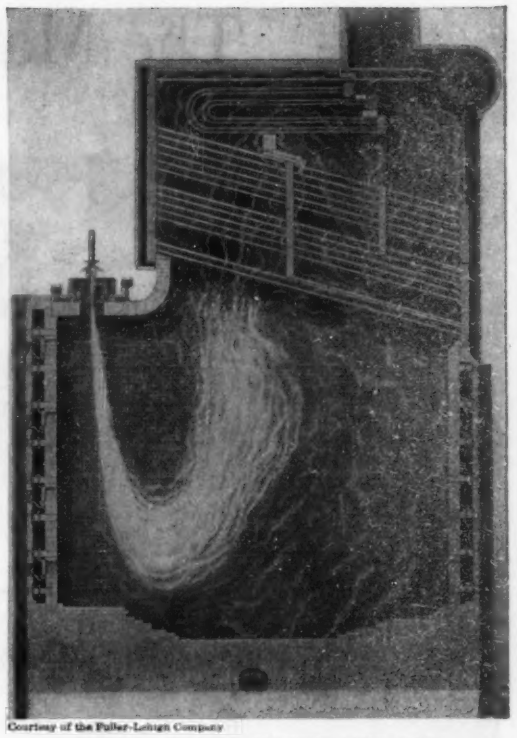
In either case the coal is ground so fine that about sixty-five percent of it will pass through a wire screen having 40,000 holes in each square inch. The remaining thirty-five percent must pass a screen having 10,000 holes per square inch. Thus a lump of coal, let us say a one-inch cube, is reduced to hundreds of thousands of minute particles having very many times the original surface exposed to the air in which it is burned. The cost of grinding the coal averages from about thirty cents to sixty cents per ton.

There are two methods of introducing the coal powder to the furnace, either by horizontal nozzle or by vertical nozzle. In the latter case, which seems to be the more efficient of the two, the coal is wafted into the top of the furnace and burns as it falls.

The air which brings the powder through the pipes to the furnace is insufficient for combustion; in fact, if it were sufficient there would be danger of premature explosion. Therefore most of the air necessary for combustion is introduced through secondary openings in the furnace wall near the nozzles. By previously passing this secondary air through the hollow walls of the furnace it becomes preheated. This increases the recovery of energy from the fuel, at the same time cooling the inside walls of the furnace and cutting off heat losses caused by radiation.

The Best Known Installation

The coal particles are consumed in a second or two, leaving an extremely fine, microscopic, gray, silicious ash. Most of this ash reaches a pit at the bottom of the furnace, where it is flushed away by jets of water. About thirty percent of the ash, however, appears to float up the stack and most of it is never again heard from.



Courtesy of the Fuller-Lehigh Company

BURNED FROM A NOZZLE LIKE GAS

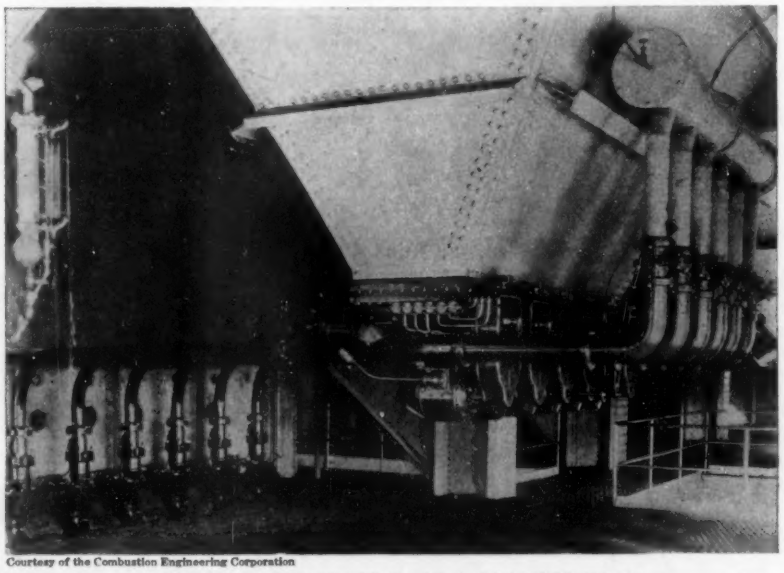
No grates are needed, for the coal particles burn as they fall

There are now at least three hundred installations for burning pulverized fuel in this country and they are all large, for as yet this method has not been applied to small installations.

Of all the many large installations, that of the Milwaukee Electric Railway and Light Company (Milwaukee, Wisconsin) is the pioneer, the leader, and the classic example among engineers. This great power plant, known as the Lakeside Station because it is situated on the shore of Lake Michigan, generates 174,000 horsepower and furnishes the entire eastern part of the state of Wisconsin with electric energy. Its great furnaces consume more than one thousand tons of coal per day.

This enormous power station was built in 1921 and began operation with a consumption of about one and one-third pounds of powdered coal for each horsepower hour of electrical energy generated.

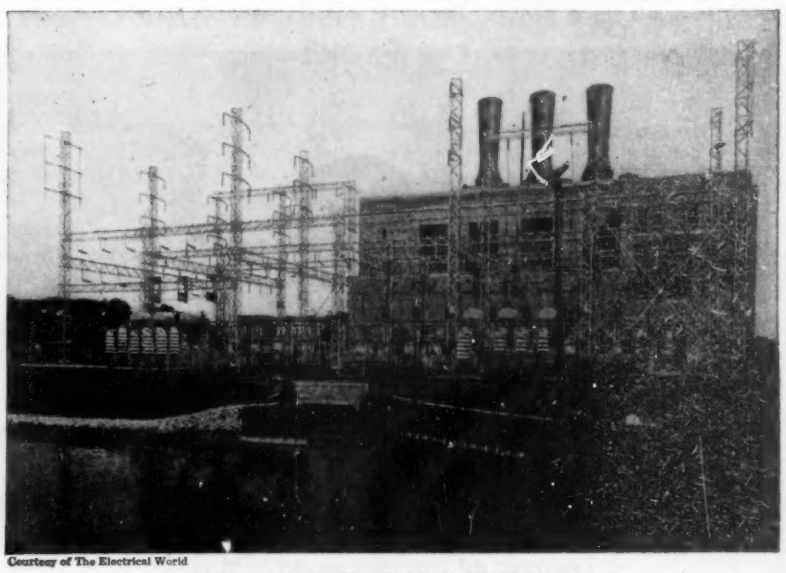
By careful supervision this amount of fuel has been consistently crowded down until less than one pound of a rather low grade of bituminous coal now suffices for the generation of one horsepower.



Courtesy of the Combustion Engineering Corporation

A BOILER ROOM AS CLEAN AS A DRAWING ROOM

Powered coal from the bin is carried by air through the pipes to the nozzles (lower left). The main floor, tiled and immaculate, is one story below



Courtesy of The Electrical World

TRENTON CHANNEL STATION, NEAR DETROIT

This immense power station of the Detroit Edison Company supplies current at 120,000 volts to important industrial centers in south-eastern Michigan

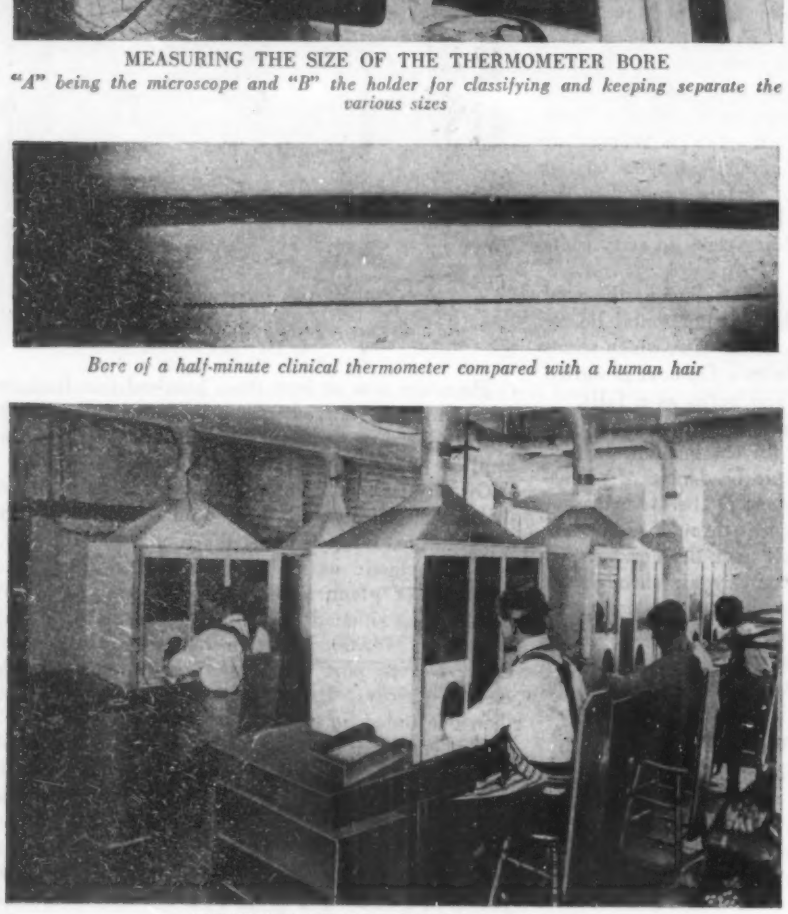
The Manufacture of Thermometers

Photographs by Taylor Instrument Company

MEASURING THE SIZE OF THE THERMOMETER BORE

"A" being the microscope and "B" the holder for classifying and keeping separate the various sizes

Bore of a half-minute clinical thermometer compared with a human hair

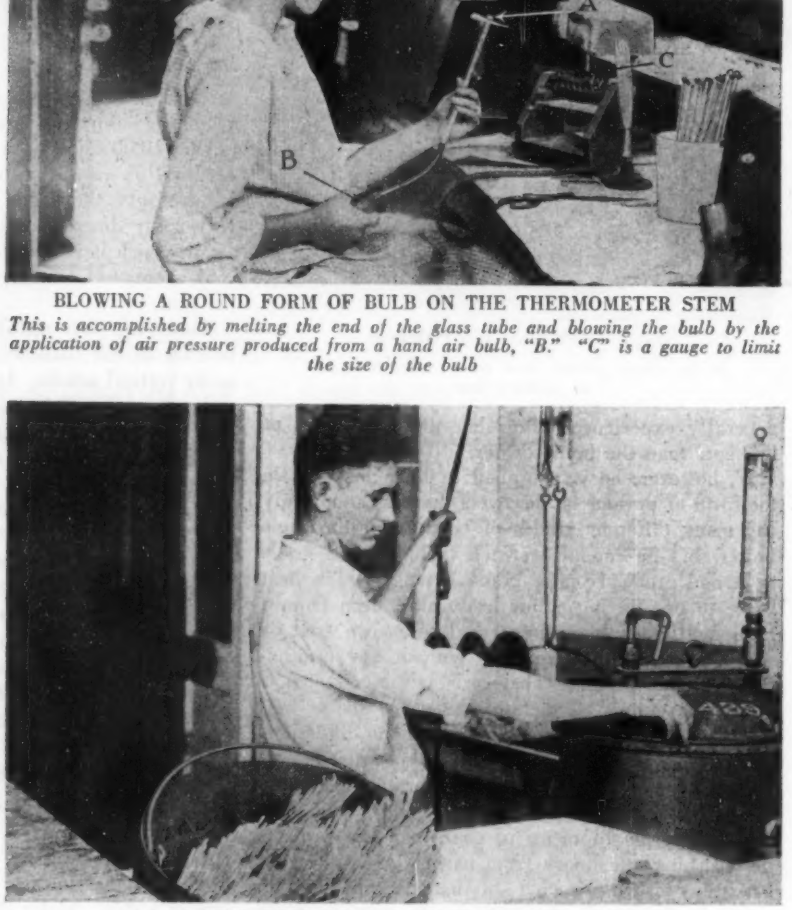


COMPLETE FILLING OF MERCURY TUBE

Here the partially filled tube is boiled by putting it into a flame. When boiled it is immersed in a cup of mercury. The partial vacuum created fills the tube completely

BLOWING A ROUND FORM OF BULB ON THE THERMOMETER STEM

This is accomplished by melting the end of the glass tube and blowing the bulb by the application of air pressure produced from a hand air bulb, "B." "C" is a gauge to limit the size of the bulb



TO COMPLETE FILLING OF THERMOMETER TUBES

The tubes are placed in a container which is submerged in a tank of permacolor liquid. The liquid is then boiled, the air expelled and the tube filled completely. The superfluous liquid is then removed so that the indicating column stands at the desired position

POINTING OR CALIBRATING THE THERMOMETER TUBES

The operation of "pointing" or calibrating is accomplished by immersing the thermometers in a bath of a uniform temperature and applying a file mark or "point" at a location coinciding with the top of the indicating column

SEALING OF THE THERMOMETER TUBE

The bulb is filled and immersed in a cold solution which draws the column down and then the tops are sealed

Are There Other Habitable Worlds?

Astonishing Deductions from Recent Theories of Energy in the Stars

By Henry Norris Russell, Ph.D.

A FEW months ago we had occasion to tell of Professor Eddington's remarkable work upon the evolution of the stars; but the tale was left but half told.

We explained how and why we had concluded that the faint red, dwarf stars, which are far cooler on the surface than the sun, are not cooler inside, but perhaps hotter—their faintness arising from the fact that the material composing them is so dense that the imprisoned heat leaks out slowly to the surface .

But another result of this new theory appears at first sight still more puzzling. It is well known that as a star contracts its central temperature must rise higher and higher until the atoms in this region get jammed close together. Eddington has shown that in the very hot interior of a star, where the outer layers of the atoms are stripped off, the density would have to be thousands of times as great as that of water before anything of the sort began to happen.

We might expect, therefore, that any given star as it contracted would grow whiter, hotter and brighter, till it became thousands of times as dense as water without any change in its mass.

Now, among the more massive stars we find what look like various stages of this process, with surface temperatures of 5,000 degrees, 10,000 degrees, and sometimes even of 20,000 degrees, and with densities increasing as the temperatures rise. But instead of running up to densities thousands of times that of water, the series stops short at a density much less than that of water. We find nothing beyond, although if such stars existed their great brightness and high temperature would make them very conspicuous. Among stars of smaller mass, like the sun, we find a somewhat higher limit of density but a lower limit of temperature. Nowhere, except among a few faint stars of small mass, do we find any evidence of the actual existence of the high densities which should be theoretically possible.

Thirty Million Degrees Hot

When we calculate the central temperatures of stars of various kinds, using Eddington's latest formulas, it appears that at the higher densities which are actually found to occur among the stars of various masses, the central temperatures are nearly the same, equalling about thirty million degrees Centigrade. It looks, then, as if there were some restrictive limitation, such that even the cores of the stars could not get hotter than a certain limit.

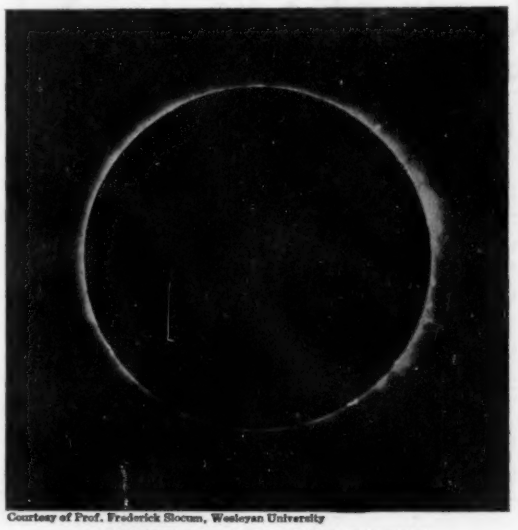
What looks like a good explanation of this comes as a by-product of the modern theory of the origin of solar and stellar heat. The sun certainly has been shining with pretty nearly its present intensity during geological time—that is, according to the best present estimates, for a billion years or so. No known source of energy would suffice to keep it going so long. It gradually has become clear that there must be some enormous internal source of energy in the sun and in other stars.

The limiting temperature is now easy to understand. At temperatures above 30,000,000 degrees the supply of heat inside the star becomes more rapid than the escape of heat. A star which got hotter than this inside would be forced to expand and so to diminish its internal temperature.

But we may still ask "What is this strange process by which this vast store of heat is created in the stars?" Several answers have been given of which the most radical of all appears now to be the best.

Ever since the discovery of radio-activity it has been realized that matter—the heavy atoms at least—possesses enormous internal energy by virtue of its own constitution. This relation, at first vague and speculative, was reduced to quantitative form by Einstein, who concluded that all energy possesses mass and that mass and energy should be interconvertible.

If, then, in some little-understood way, this transformation of matter into heat becomes actual within the stars, a tremendous amount of heat may be created at the expense of a slow decrease in mass. When a star has reached the critical central temperature mentioned above, it may be expected gradually to "burn itself away"—as Eddington puts it—diminishing in mass and passing down the series from the great white stars like Sirius to those resembling the sun and the redder dwarfs.



Courtesy of Prof. Frederick Slocum, Wesleyan University

EVIDENCE OF THE SUN'S ENERGY

The projections on the edge of this photograph of the sun, taken during the recent eclipse, are solar prominences, flames of hydrogen nearly a hundred thousand miles high

The flood of outgoing heat from the sun is so huge that, on Einstein's principles, the mass of our luminary must be diminishing at the rate of four million tons per second. But the sun is so massive that, even at this almost incredible rate of heat-loss, it will require 150 billion years to use up one percent of the sun's mass. The whole past history of the sun is estimated by Jeans as about 7,000 billion years. Its future span of life should be fully twenty times as long.

Good reasons for regarding such a bewildering stretch of time as real are found in a recent paper by Jeans, which discusses various results of such a slow decrease in the mass of a star.

So long as the mass of any star—say of the sun—remains constant, the size of the orbit of a planet revolving around it (or of that of one of a pair of double stars revolving about the other) will remain unaltered unless other forces than gravitation are at work. Such another force is found in the friction of the tides which each component of a double-star pair raises on the other. It has long been known that this tidal action tends to separate the components and enlarge the orbit.

During this process, an orbit which was originally nearly circular (as it must have been when the components were nearly in contact) could increase somewhat in eccentricity, but no one has ever been able to show mathematically how tidal action could produce the very high eccentricities which are common in double-star orbits.

A few years ago Jeans showed that these high eccentricities could be explained by the effect of chance encounters of other stars with such double-star pairs. If, while the components are pursuing nearly circular orbits, another star passes close to them, its attraction will disturb their relative motion. This will change an originally circular orbit into an ellipse, and Jeans has proved that if a large number of stars were subjected to numerous encounters the final distribution of high and low eccentricities would be not far from that which is observed among the known double stars.

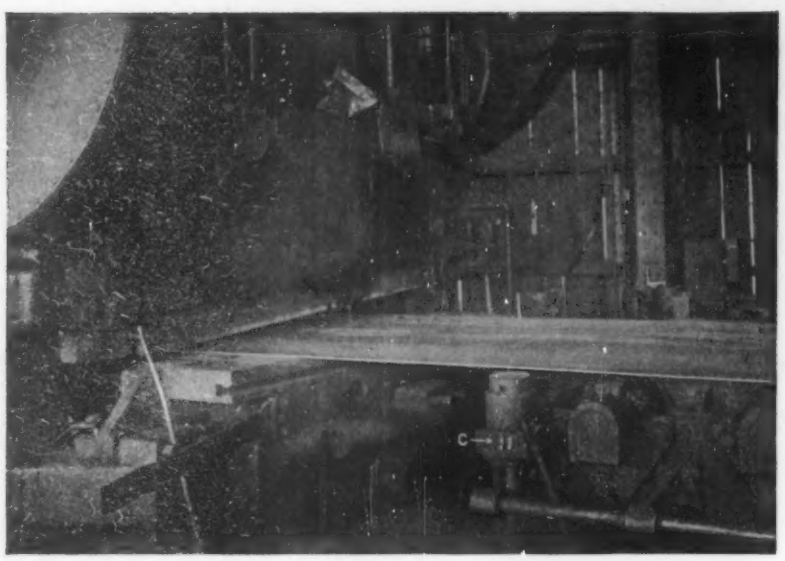
Our Universe Is Expanding

Now an elementary calculation, based on the known masses of the stars and on the thickness with which they are sown in space, shows that any given double star would encounter another star closely enough to produce much change in the orbit only once in some 4,000 billion years. When the life of a star was believed to cover only a few billions of years at the most, these encounters appeared to be of negligible importance. Even with the enormously increased time-scale allowed by our new outlook, it does not seem, at first sight, that there would be time enough for the necessary encounters; but Jeans points out that if, as is very probable, the stars of the Milky Way are kept from wandering into outer regions of space by the attraction of the whole mass, and if they are slowly losing mass, the whole galactic system must be slowly expanding.

In remote times, then, the stars must have been nearer together and encounters must have been more frequent. This correction is found to give us just about enough encounters to produce the observed distribution of double-star orbits.

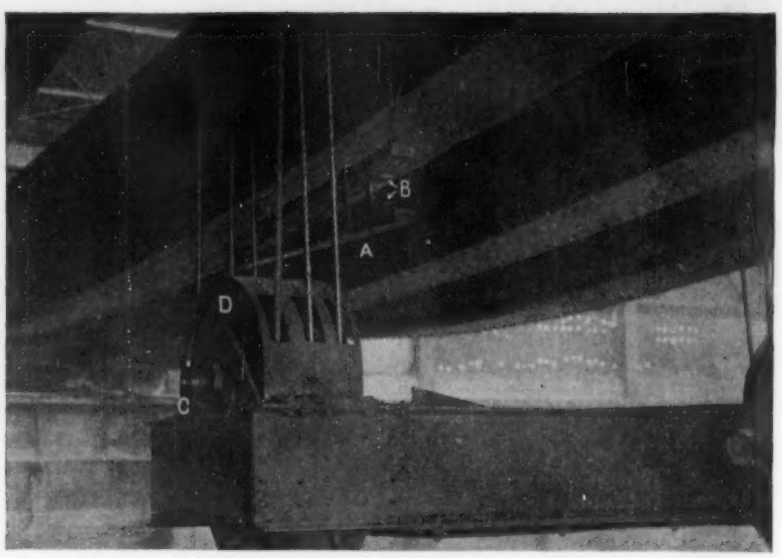
From two independent lines of evidence, therefore, there is good reason to believe that the past history of our starry universe runs back for billions of years. This has a most important bearing on another question which has long excited great interest—that of the plurality of worlds. Are there among the stars many planetary systems like our own solar system? If so, there may well be habitable worlds among them, with living creatures on them. If not, our peopled world may be unique.

Everybody knows, of course, that we could not see planets revolving about even the nearest stars—they would be far too faint to be detected. We must depend upon inference. Now there is good reason to believe that the planets of our system were produced by eruptions from the sun, under the influence of an encounter with a star which passed unusually close to it. So close an encounter, according to Jeans' calculations, should happen not oftener than once in ten trillion years, perhaps even more rarely. With the shorter time-scale for the universe it appeared that planetary systems should be exceedingly rare—indeed, it was possible that our solar system was the only one. With the longer time scale the genesis of such systems becomes in Jeans' words, "a somewhat, although not excessively, rare event." We may now believe that there may be millions of planetary systems among the stars and perhaps thousands of worlds which are the abode of life.



SAFETY DEVICE IN A SKELP MILL

When necessary for a man to enter the space between roller table and shear, bar gate is opened which breaks the controlling circuit at contractors C. This deadens the roller table and thus prevents a plate being run down on a man working on shear



SAFETY DEVICES ON BESSEMER CRANE

A is a safety limit switch to prevent over-travel of hoist. The carbon contacts B are brought together when the hook block raises the hinged arm of switch A, short-circuiting the armature and stopping the motor. C—safety grease cup. D—shield over sheaves

Story of Steel—XIII

Mechanical Safeguards and Safety-first Teaching Protect the Life and Limb of the Steel Worker

THUS far in the present series on the manufacture of steel we have dealt exclusively with the mechanical aspects of this fascinating subject. It is time surely that we said something about the human side—about the men who so deftly and with such easy familiarity control the vast and awesome machinery, and move day by day and night by night among the volcanic fires and ponderous appliances of the furnaces, foundries and rolling mills which have been depicted in the previous chapters.

If space permitted we would gladly dwell in much detail upon the human side of all this and tell how the toiling myriads employ their leisure hours—that is to say, how they live and play; but that must be left for a succeeding chapter. Just now we are concerned with the ever-present and all-important matter of the safety of the employee while he is at work—the protection of the workman against injury and sudden death.

Steel Corporation Protects Its Men

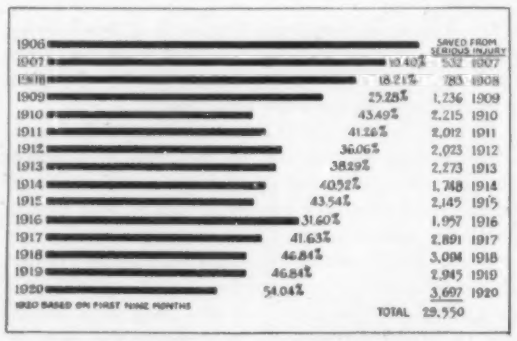
The public at large knows all too little about the very fine work which has been done by the great industrial interests, and notably by the United States Steel Corporation, to protect their workmen against accidents. On the contrary, the public has been made the victim of a false and very vicious propaganda which seeks to convey the impression that the policy of these great corporations aims at getting out of the employee the greatest amount of work with the minimum of expenditure to themselves. In other words, there is an endeavor to show that the workmen are being treated as so much property, to be exploited without any regard for their human and spiritual interests.

Now one of the greatest and most pleasant surprises of the writer's recent extended tour through the great steel works of the country was to find on what a carefully-thought-out and extensive scale the problem of safeguarding the workmen is being solved. Many years ago the United States Steel Corporation organized a Bureau of Safety, Sanitation and Welfare, whose activities, under a general manager and a very large staff, cover the whole field of the corporation's steel activities. This good work started in the year 1908, at which time the casualty managers of the different subsidiary companies were called together and Judge Gary addressed them as follows:

Judge Gary on Safety

"Some of the gentlemen present, if not all of them, know that I am in hearty sympathy with the movement. We should like to take a prominent part, a leading part, in any movement and in every movement that is practical to protect employees of the different corporations in which we are interested; any requisition which is made for the expenditure of money to install equipment to protect our people will be honored, and I do not hesitate to say that we expect our legal department, and the gentlemen who are subject to their control (these casualty managers were under their control at that time) and direction and advice, to take such steps as are practicable to ascertain anything that can possibly be done at every locality and in every department to add to the safety of our equipment and to prevent accidents."

At a later date Judge Gary wrote to the presidents of the subsidiary companies—"The United States Steel Corporation expects its subsidiary companies to make every effort practicable to prevent injury to employees. Much can be done by designing new construction and machinery with all practicable safeguards. Expenditures necessary for such improvements will be authorized. Nothing which will add to the protection of the workmen should be neglected. The safety and welfare of the workmen is the greatest concern."



ACCIDENTS 1906—1920 INCLUSIVE

Percent decrease in accident rate 1906 to 1920 per 1,000 employees. 29,550 employees have been saved from serious injury in fourteen years

In the intervening years there has been built up a vast welfare organization, the result of whose work is shown in the accompanying graph entitled "Accidents 1906-1920, inclusive," from which we learn that, during that period, in spite of the rapid growth of the various industries and, therefore, of the total number of employees, there has been a reduction in the number of accidents of 54.05 percent, and that up to 1920 no less than 29,550 employees had been saved from serious injury.

Developing Safety-first Instinct

The diagram needs some explanation. There is an increasing rate of drop in the first three years; and in 1910 the rate of decrease is nearly doubled. This is due to the large number of employees in that year. The decrease in the rate in 1916 shows the disorganizing effect of the great rush of war work and the number of new men introduced.

The effort of the corporation to safeguard its employees against accident may be classified under two heads—first, the provision of mechanical safeguards around the moving machinery; and second the training of the employees in habits of carefulness and the avoidance of unnecessary risk. A study of 220,707 accidents reveals some unexpected and very illuminating facts. In the first place, it was found that only 4.94 percent of the total number, excepting those in connection with overhead electric cranes, were due to machinery causes. While this low percentage is due to the protection of the mechanical safeguards installed, Mr. Charles Close, the manager of the Bureau of Safety, assures us that the

MACHINE SHOP SAFETY DEVICE

Special clamp for handling car wheels by crane from one part of the shop to another. Note handles on keeper to facilitate sliding same up and down

accidents represented even by this low percentage do not indicate that the machines were not properly guarded, since employees do get hurt through their own carelessness, even though the machines are completely equipped with safety devices.

Hand labor, we are told, caused 44.42 percent of these accidents, the majority of which cannot be controlled by any safety devices and appliances. The conditions under which these accidents occur are almost wholly within the control of the workmen, and are due largely to their thoughtlessness or carelessness. In addition to these hand-labor accidents there are hundreds of others where the carelessness or thoughtlessness of the employees were contributing causes. As a matter of fact, a careful analysis of any 100 accidents shows that at least 90 of them might have been prevented if a little more care had been exercised.

A Few of the Safety Devices

We have selected a few photographs of safety devices which will serve to show the character of this work. Our first view shows a hinged bar which, when it is closed, prevents a workman from getting in between an approaching heavy plate and the shears. These plates are brought forward to the shears by means of a table of rollers operated electrically. The current for supplying the motors passes through the hinged bar when it is in the closed position. When the bar is open, as shown in our view, it breaks the electrical circuit, stops the roller table, and thus prevents a plate from running down on a man and pinning him between the forward edge of the plate and the shears.

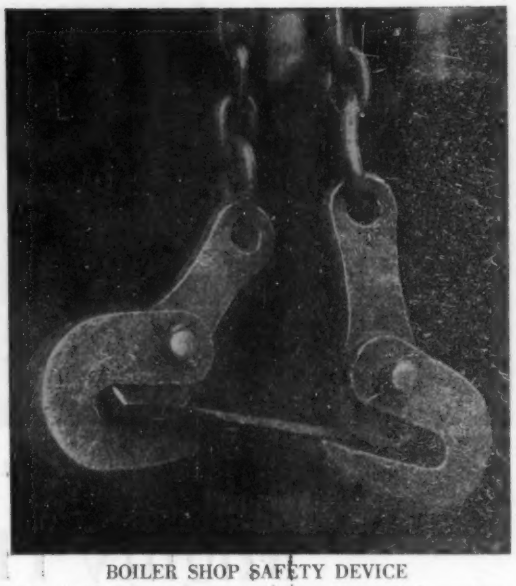
The adjoining picture shows a device to prevent over-travel of the hoisting gear which lifts the ladles, the largest of which may contain as much as one hundred tons of white-hot molten steel. If the heavy beam upon which the ladle is hung rises above a certain point it strikes the bar "A" and short-circuits an armature, thereby stopping the hoisting motors. Were it not for this device the beam would strike the under side of the steel girders above, the cables would be broken, and the mass of steel would be precipitated upon the men working below.

There is always danger from weights slipping from a crane, and we show two clamping devices which would prevent accidents of this kind. Then there is the danger of flying chips from a turning lathe, and an effective safeguard to the face and eyes consists of a stout glass plate between the work and the operator. Our last engraving shows safety devices for preventing injury to the hands when oiling a heavy planer, or the crushing of a workman between the sliding bed and the base of a planer.

Most Accidents Due to Carelessness

The experience of the Safety Bureau indicates that more accidents happen where the conditions are entirely within the control of the workmen themselves, and are, therefore, due to carelessness or thoughtlessness, than those which are directly due to machinery causes.

Now this analysis shows the enormous importance of the safety-first campaign which is being carried on ceaselessly by the Safety Bureau, in the effort to induce in the workmen what might be called a safety-first instinct. Mr. Close believes that there will come, ultimately, a day of no accidents, but he believes that to bring that about it will be necessary to develop a new generation of workmen. This can be done by training the child so that he will develop habits of safety. It is not enough to show him the safe way of doing things once, twice or a dozen times. To get results it is necessary to teach him the safe way of doing things every day "so that



BOILER SHOP SAFETY DEVICE

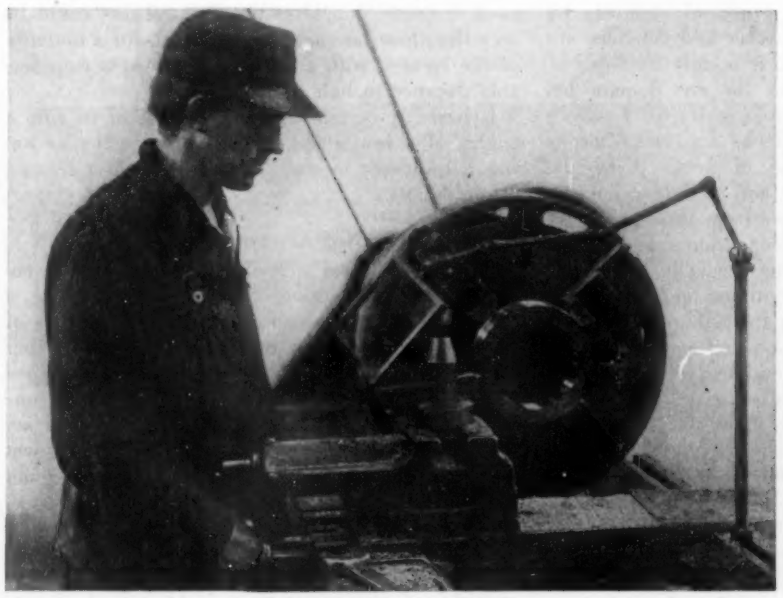
The chain sling with special clamp hooks used in carrying plates. This view shows one hook engaged and one hook hanging loose

when he comes into the shop as a workman he will habitually do the safe thing, just as his father today seems habitually to do the unsafe thing."

Hold the Foreman Responsible

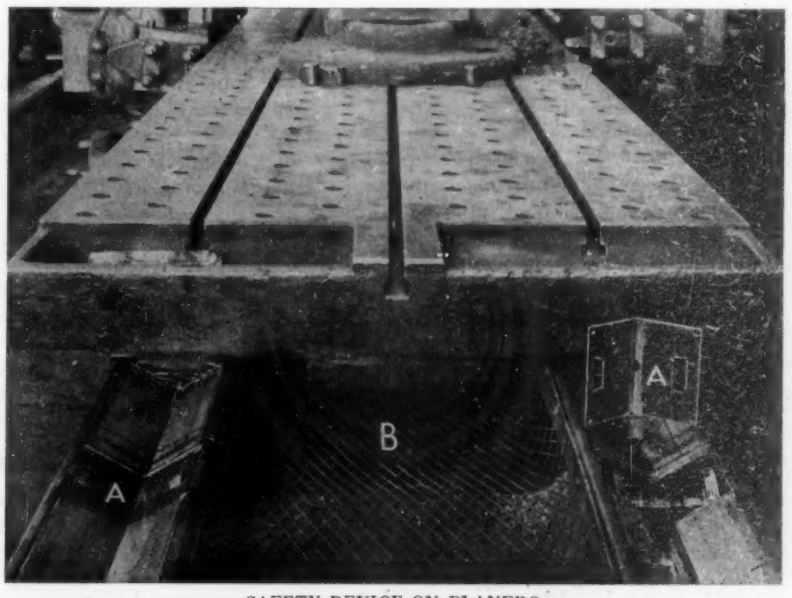
It is believed that under the existing conditions, and with the present generation of workmen, safety can be promoted by holding the foreman responsible for the accidents in his department, and by charging the accident costs against the cost of his product. The foreman is in his position to keep up production and to keep down costs. The cost of accidents ultimately is included in the cost of the manufactured product, and Mr. Close suggests that this should be included in the manufacturing cost of each department, thereby impressing it upon the foreman whose men are having accidents that the work of his department is more expensive than that of the foreman whose men do not have accidents.

Of course the trouble is to be explained as verifying the truth of the old saying that "familiarity breeds contempt," and it is this day-by-day familiarity with danger that leads the workmen to look upon disablement and death, not so much as an ever-present threat but as companions that are so familiar that they lose their sinister aspect.



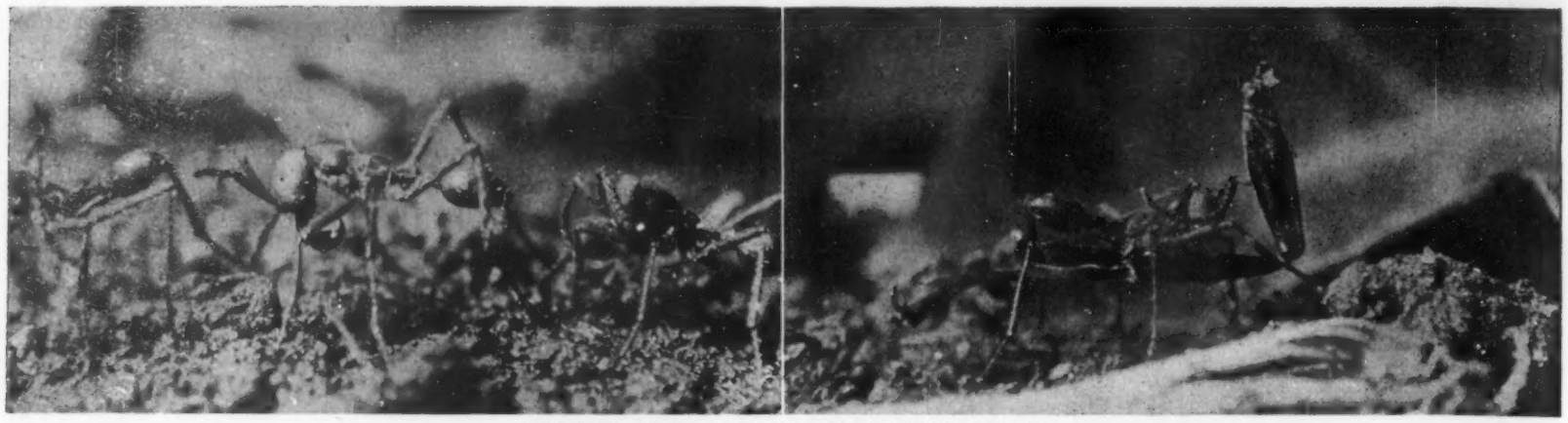
CHIP SHIELD ON LATHE

Heavy plate glass shield to protect operator's face and body from flying chips. The shield is supported by a universal jointed arm secured to the tool carriage so that it can be readily adjusted to any position



SAFETY DEVICE ON PLANERS

A—shields over oil pocket prevent injury while reaching into pocket. Left-hand shield down with top rollers exposed. Right-hand shield removed from oil pockets. B—net to prevent a man from being crushed between the sliding bed and base plate of planer



MARCHING ARMY ANTS FROM THE GUIANA JUNGLE

LEFT: *Army ants marching in single file: note the great killing mandibles on the central figure (magnified five times).* RIGHT: *Army ant bringing home as booty the leg of a victim. This straddling of the burden is characteristic*

Mighty Hunters in the World of Ants

Some Epic Encounters that Go On Each Summer Hour Within the Grass-blade Forests of Our Lawns and Fields

By S. F. Aaron

Drawings by the Author

ALL species of ants—of the honey-making, the agricultural, the carpenter, the aphid-herding, the fruit-eating or the leaf-eating—are commonly omnivorous and it is not unusual to see materials of all kinds, even in the remotest sense edible, dragged to the colony domicile for the feeding of the young. With those forms of ants that do not make any special effort to acquire certain foods, honey dew probably comprises the largest bulk of their harvest. Nearly all forms are first attracted to the herds of aphids, or ant cows, that happen to become located in numbers on weed stems, rose bushes or tree twigs within ranging distance of the ant colony.

On the ground this ranging distance may not exceed, even for the largest home-making ants, more than a few yards, but into trees, or over elevated waysides, as, for example, a fallen tree trunk or a fence, it may extend more than a hundred feet, often to the topmost branches of a forest giant and then some space from its foot.

The Smaller the Ant the Bigger Its Load

Next to the desire for milking aphids for their sweet nectar, ants seem to prefer a carnivorous diet and they are constantly on the lookout for game, without any special regard for one kind over another. As hunters they are as diligent as when in quest of more easily acquired food. Their intrepidity permits them to attack anything which their keen sense of smell informs them is not a foeman altogether beyond their strength, although in defense of the home or of the ant-cow pastures they do not scruple to attack anything that threatens, leaping upon the bill or feet of a bird, the snout of a mouse or a shrew, or even upon the investigator's projected finger and being apparently willing to be sacrificed in the single-handed effort to hold off an enemy.

Invertebrates of all kinds, insects mostly of course, but also centipedes, millepedes, spiders, pedipalpi, sow bugs and earthworms, are welcome grist to the ant mills which, unlike those of the gods, grind rapidly. The smaller the ant the bigger its load and the more daring its captures, but these are never so easily observed and hence seem much less common than the hunting experiences of the larger species. The big black carpenter ant is the commonest and, with the big red ant, the largest of our North American Formicidae. It is also the most agile, the bravest and probably the most varied in its foraging habits. It may generally serve as an example for all of its relatives, big and little and of every species.

It often happens that there is no colony of aphids located near an ant colony and, therefore, almost the entire ant commissariat must be of captured game. One may wonder, if there is anything in the idea of the influence of food upon racial characteristics, whether the young of ants reared carnivorously become braver in battle or more warlike than those depending solely on honey dew for their food, but such evidently is not the case with the black carpenter ants.

The method of ants in capturing their prey is that of mere strength and agility, with a very certain readiness for permanent retreat when overmatched, or of temporary retreat and swift counter-attacks when meeting with severe opposition. Aside from this latter show of caution, coupled with a fierce determination, there is no practiced cunning, no stealth nor strategy. The attacker and defender are often so evenly matched that it is only by force of numbers that the invader of the ant domain becomes a victim to the insatiable desire for food.

The winged, six-legged folks have a certain means of retreat from the attacks of ants. Even the stingers, including the digger and mud dauber wasps and bees, are glad to get away from these persistent foes of every other crawling thing. Large and powerful beetles slow to take wing, heavy-bodied caterpillars, great hairy-legged ground spiders, swift, gliding centipedes and leaping grasshoppers are not easily overcome by herds of ants and most frequently make their escape, either ploddingly, or by swift retreat, now and then leaving some dead and dying ants in their wake.

Ants Have No Means of Signaling

These reinforced attacks of ants upon desired victims have been somewhat exaggerated; the subject is a fruitful one for the story tellers who have relied on the common practice of quoting and have not given the investigators credit for close observation. It can be stated with certainty that ants have no means of signaling for the aid of their fellows when making an attack upon a slow-moving insect too big for one ant to manage. The sudden swarming of ants around the contestants is simply explained by the fact that anywhere within the hunting range of ants there are nearly always many rangers and these soon come upon the struggling pair. With equal certainty they come upon one of their own number with a load it can easily carry yet they insist upon helping. Or, on the other hand, dozens of ants may pass close by one of their fellows in difficulties and not discover its plight.

With amusement, yet with a certain sympathy, one may behold a very determined ant seize the leg of a resting butterfly, moth or dragon-fly and suddenly find itself carried into the air. I once saw a persistent black carpenter, that was defending a herd of aphids, grab a red admiral butterfly which was attracted also by the honey dew. The surprised visitor was not slow in using its powerful wings. At such times ants determinedly stick tight in order to inflict punishment upon the trespasser. An ant may grip your finger with its jaws for half a minute until it nearly punctures the skin. There could be no telling how far that ant journeyed, for a butterfly of the species, with a bitten leg can go a considerable distance in half a minute.

It is pretty certain that for the rest of its life, a matter of a few weeks at most, this particular ant was a wanderer in strange regions, always seeking for its home.

Ants Not Always the Victors

One of the most difficult tasks that an ant encounters is the dragging of a stout beetle or bug, a blue-bottle fly or a wood roach, the many claws of the victim catching in every grass stalk or other obstruction and often defying the most determined pulls and jerks to get it loosened. Watching one such effort from time to time, with an eye on my watch, served to demonstrate that one ant spent nearly two hours pulling a stout Noctuid moth about five and a half feet through a tangle of grass stems, being aided or hindered now and then by a few of its co-workers. Another ant put in nearly as long a time getting a large black Tachinid fly less than nine feet up a tree trunk, the odd part about this last grand effort being that the nest was at the base of the tree and the labor was entirely futile. The

ant finally discovered this and the fly came down little faster than it went up, but was at last, when near the colony habitation, torn apart by a swarm of ants and carried in piecemeal.

There is nothing more amusing in the complicated affairs of nature than an encounter between an ant and a caterpillar, the former determined to make the latter food for its nurslings. The manner of defense of all caterpillars that are not armed with urticating spines is to double and squirm about in such a way as to reach the enemy with the head and effective mouth parts that secrete not only silk for the cocoon, but deterrent liquids that are more or less distasteful and even poisonous. This protective liquid is of the same nature as the brown exudation from the mouth of a grasshopper that leads children to issue the order: "Spit tobacco and I'll let you go."

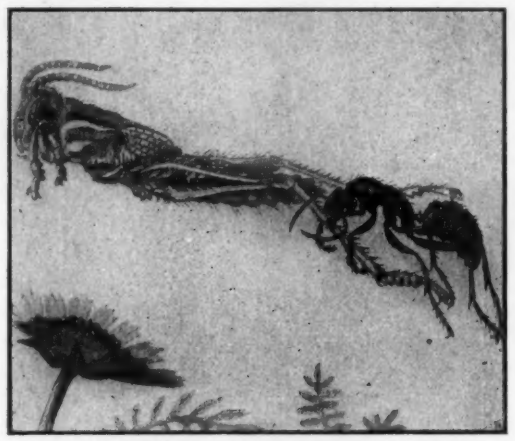
The exudation from most caterpillars is greenish; it is sticky and irritating even, no doubt, to the thick, chitenous exo-skeleton of predacious insects. It is evident that the ant that tackles a caterpillar is a true patriot and deserves the commendation of its co-workers, though it only desires to obey its instincts and, therefore, its determination to make the caterpillar food for its young.

The writer of this account witnessed such a contest which, however, ended quite differently from most battles of the kind.

Larger Insect the Victim

The brown and dark-streaked larva of a Geometrid moth, this and its relatives being commonly called measuring worms, was about three times the bulk of its would-be captor. Rearing up on its extremely posterior legs the caterpillar proved capable of swift and decided means of meeting its foe at every angle, conducting a defense for which its usually lethargic nature deserved much. Moreover, it seemed never to exhaust its store of repellent juice. But the valiant and well endowed defense on the part of the caterpillar was equally matched by the fierce if somewhat unworthy attack of the comparatively almost insignificant aggressor.

A carpenter ant's sole weapons are its jaws. Aside from these it has what in the parlance of pugilism and fencing is called foot work. In comparison the caterpillar appeared almost as though remaining fixed, though it did squirm about so as to cover nine or ten square inches, the ant getting over a square foot or more of space in its retreats and attacks which consisted of a series of rapid charges. The ant seized the caterpillar with its jaws and immediately let go when the worm's head came around like a catapult and smeared the aggressor with that protective exudation. The ant retreated several inches and rapidly endeavored to clear its body, legs and antennae of the irritating fluid—a matter of some twenty seconds, when it charged in again. The caterpillar meanwhile feeling the injury from the jaws continued its squirming as though in a fire. Finally the ant took so long between attacks that the caterpillar was able to make one stretching reach up a short weed stem and, although upon its next hunt for its desired victim the ant passed over all of the ground—even directly under the caterpillar not two inches above it and kept this up for more than ten minutes, it at last gave up the quest and disappeared.



STICKING TIGHT TO INFLICT PUNISHMENT

Sometimes powerful wings or legs take the ant in the wrong direction as does the long leap of this young red-legged grasshopper

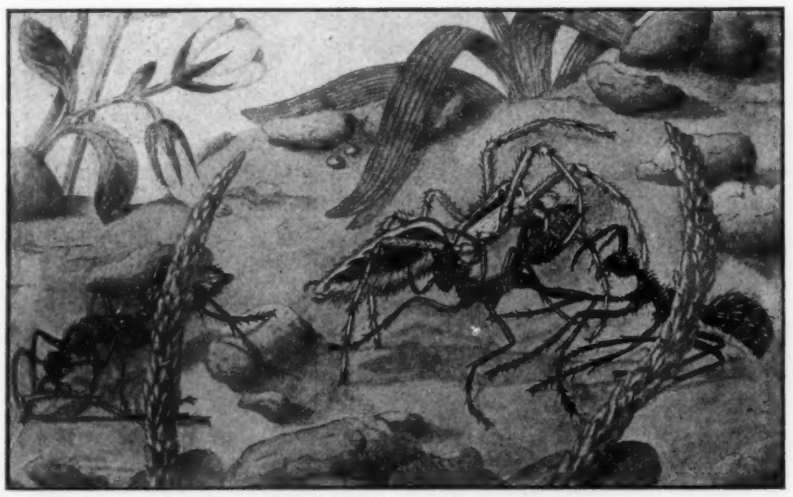
More tragic is an ant's capture of a ground spider, one of the funnel-web builders, Agelaena. The two are generally about of a size. If the spider is quite large it makes good its escape, or it may kill the ant. I have seen the latter prevail when the spider was fully one-half larger and also a large brown Lycosid fall victim to half a dozen ants. There were some dead and injured carpenters, however, before they conquered. When the two are more evenly matched and there is but one of the aggressors it is a sanguinary affair and after a time pretty much one-sided. The ant seizes the spider's leg and according to a means of protection common with many arthropods and some lower vertebrates, the captured member is instantly shed; whereupon, if the ant is satisfied with that and anticipates no greater prize, it makes off, but more frequently it drops the leg and makes another attack, so that often the spider may quickly lose half of its legs. I have even seen it deprived of all but two. Thus disabled it becomes an easy prey to the ant. But sometimes, in its eagerness to seize a more vulnerable or less transient hold, the ant is itself seized by the spider, though the latter's jaws must be powerful enough to puncture the ant's hard exo-skeleton in order to harm it. This done the ant almost instantly succumbs to the spider's poison. It is, however, not unusual for the struggling, agile and equally powerful ant to make counter-use of its jaws and it generally gets away from the spider's hold in a jiffy, attacking again instantly. In nearly every such instance the spider proves to be the unfortunate victim.

Not explicable in this connection is the contest between a crab spider and a black ant. Lying in wait on wild carrot or other wide-flowering heads this snarer of unsuspecting insects will seize a visiting ant, hold and quickly kill it. But whenever the crab spider wanders from its lair and travels within the hunting range of the ants it will be attacked and torn apart even by a small member of the colony, the ant attacking in the usual way and freeing the spider of legs, although the two pairs of longer and stronger prey-catching extremities are never parted with when seized and they serve both protectingly and aggressively in the hard fight that follows. Moreover, they catch in every obstruction and altogether they make the ant's task exceedingly difficult.

The feud between ants and the ambush bug, one of the assassin group, is similar to that of the ant and crab spider. The bug in its lair within flowers that are attractive to honey seekers takes toll of these unsuspecting lovers of sweets exactly as do the spiders and with even greater success in immediately reducing the victims to a condition of helplessness, for the puncturing proboscis is a more deadly weapon than the spider's jaws. Moths, butterflies and beetles and even bees three and four times the size of the ambush bug succumb to its powerful grip and thrust, and black carpenter ants are not infrequently among the number.

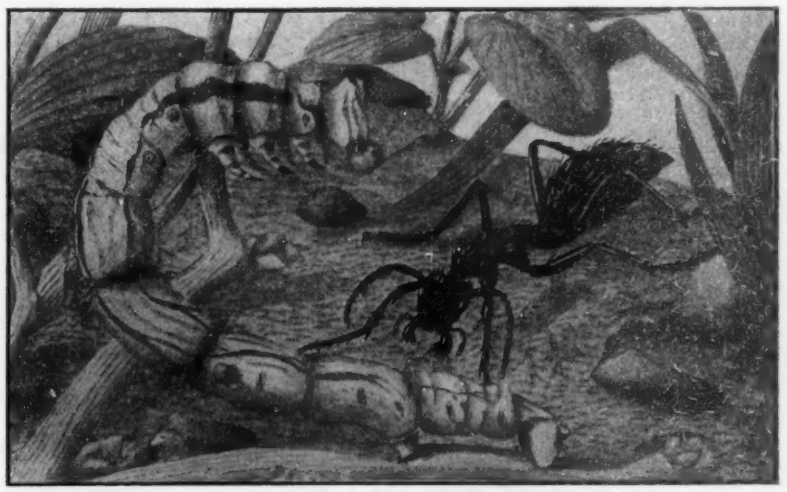
A Case of Catch as Catch Can

Imagine, then, the surprise one must feel upon seeing an active ambush bug being dragged by a black ant toward the nest. Evidently this was a case of catch as catch can. The bug, with its thick, especially muscular and spined forelegs had failed to seize the ant; the latter had instead seized the bug's more normally proportioned posterior limb. Taken unaware the assassin only tried to hold on at first to its chosen situation and then to everything in the way of progress toward being served as food.



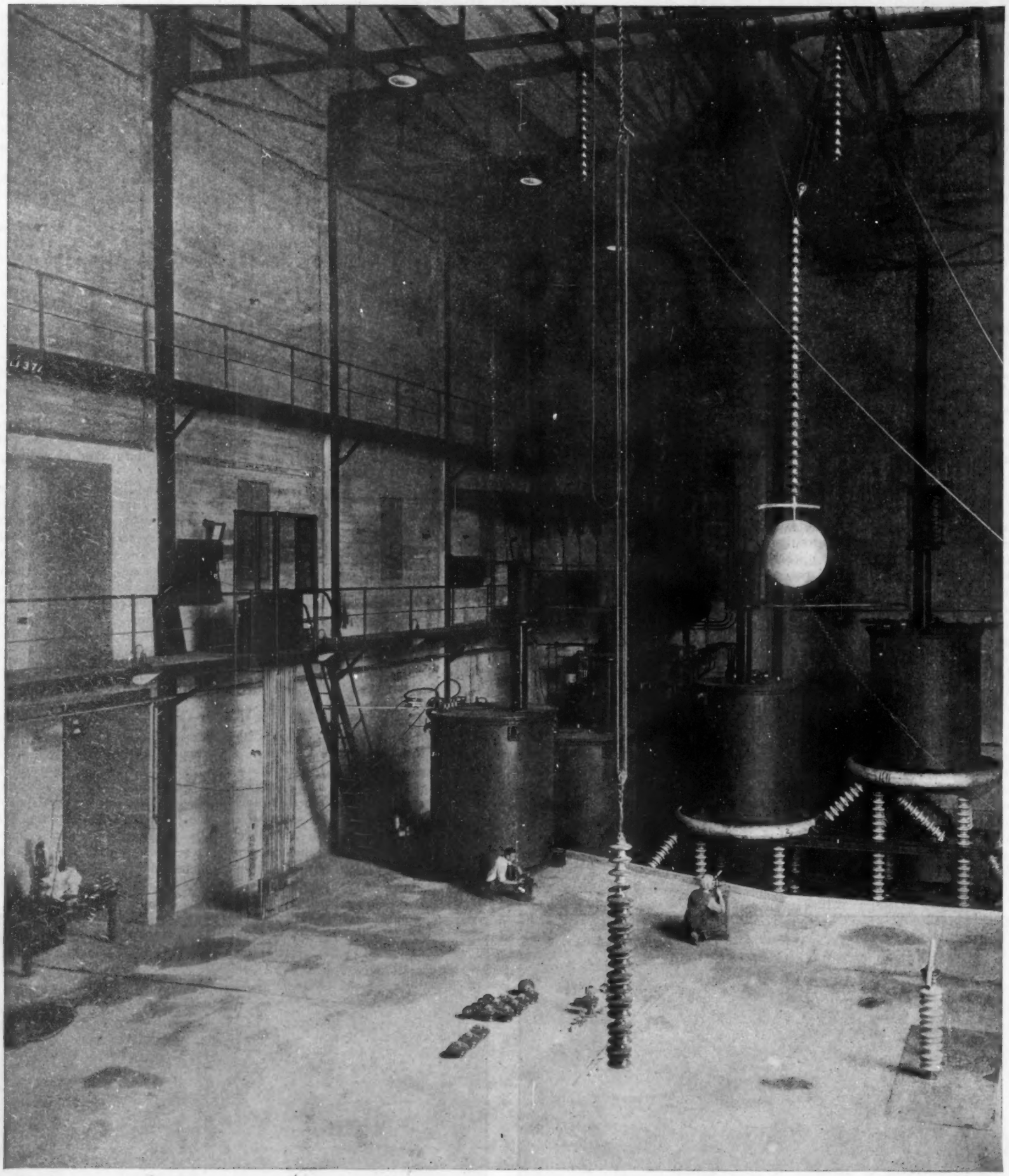
CARPENTER ANTS CAPTURING A SPIDER

The victim has seized one of its foes and may inflict, through its venomous fangs, a fatal wound. An ant has severed one of the spider's legs and is carrying it away



AN ANT ATTACKING A MEASURING WORM

The worm successfully defends itself by means of rapid squirming and by exuding the sticky, green secretion from its mouth, which the ant seems to dislike greatly



This Laboratory Can Supply Electric Currents with the Tremendous Potential of Over a Million Volts

The transformer units shown are a part of the equipment of the remarkable new high-voltage electric laboratory recently completed at the California Institute of Technology, Pasadena, California. The great size of the installation can be judged from the tiny figures of students making observations, one of them through a telescope so that he can avoid approaching the dangerous current. Under the direction of Professor Royal W. Sorenson this laboratory will be used to study the structure of atoms as well as many problems in electrical engineering.

Inventions New and Interesting

A Department Devoted to Pioneer Work in the Various Arts and to Patent News

Conducted by Albert A. Hopkins

Brass Wire Brush for Suede Shoes

SUEDE shoes need a little brushing up to renew their youth and nothing is better for this purpose than a brass wire brush which by raising a nap revives them to a remarkable degree.

A Plane Advertises a Garage

THE relation between a garage and an airplane seems rather remote, except that the proprietor would probably sell gasoline to anybody. A London garage owner bought a regular plane for a song, took the wings off and mounted it on top of his shop.

Heat-a-knife. Furniture Patchers' Electric Furnace

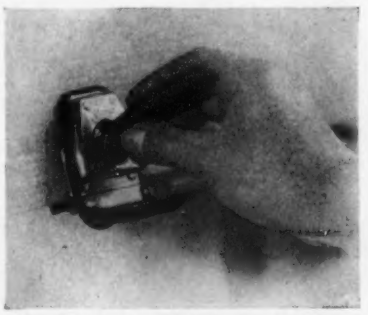
A MODERN furniture factory had a fire, causing the death of two workmen, due to the use of flame torches. The furnace shown is designed for continuous duty for

For raising the nap on suede shoes

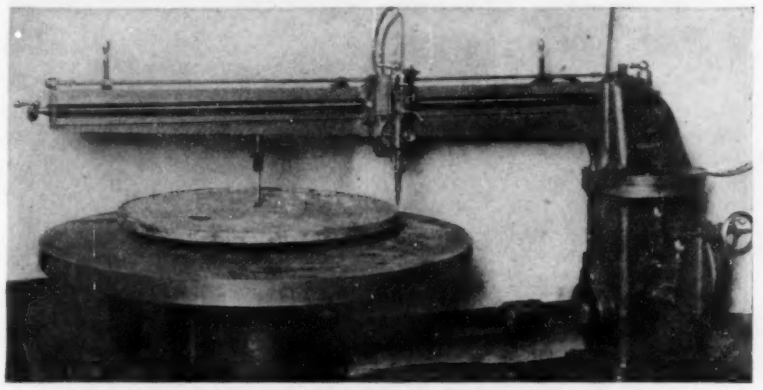
heating furniture patchers' knives. This heater is very economical in current consumption, the size of opening being large enough to accommodate a knife from either end. Size of opening, $\frac{1}{16}$ of an inch wide, $\frac{1}{16}$ of an inch high. Length of cylinder, 5¼ inches. The aluminum cylinder is mounted by means of two aluminum end castings. The end castings are mounted on an asbestos base. The knives are placed in the furnace lined with monel metal, which will not rust or scale.

Automobile Cigar Lighter

THE cigar lighter illustrated hails from Racine, Wis. It may be mounted on the instrument board of an automobile. There is a large heat unit and an automatic switch allows the current to flow from the electrical system of the car. When the cover is pressed with the fingertips the heat unit flashes to a bright glowing heat.



An efficient automobile cigar lighter

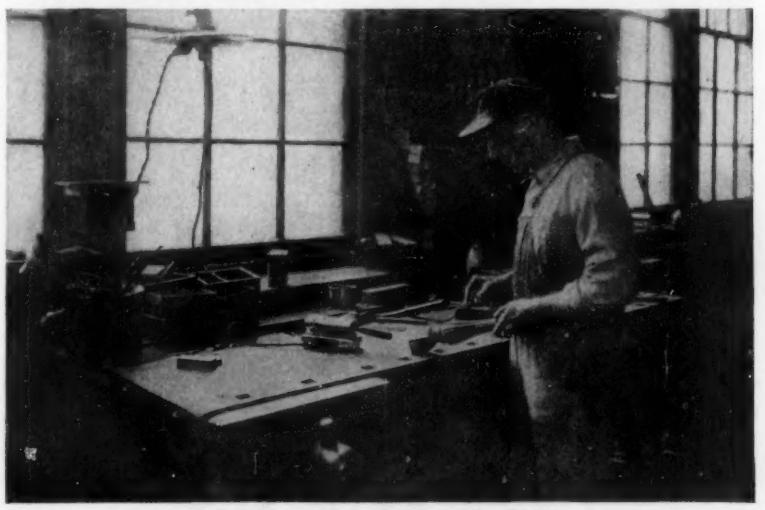


Universal gas cutting machine will cut disks eight feet in diameter

An airplane advertises a garage

A Universal Gas Cutting Machine of Great Range of Work

STEEL discs, angles, bars, "half moons," and shapes of all kinds, varying in thickness from one-eighth inch to six and three-quarter inches, can be cut on this universal gas cutting machine in use at the Pittsfield, Massachusetts, works of a great electrical manufacturing company. The gas used is a combination of hydrogen and oxygen, the pressure varying from fourteen pounds for one-eighth inch steel to seventy-eight and one-half pounds for six and three-quarters inch steel—the greatest thickness ever cut on this machine. Discs of 108 inches diameter can be cut. In cutting discs, the steel revolves on the circular table, the cutter remaining stationary; while in cutting squares, etc., the steel is stationary and the cutter moves along the track.



A furniture patcher's heater for knives

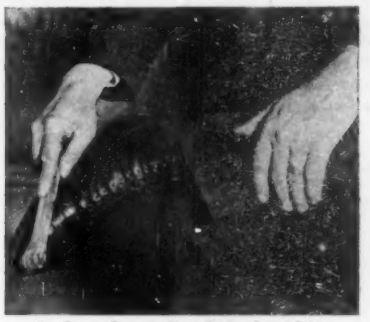
Mr. Vauclain and the Deisel Locomotive

THE Diesel internal combustion locomotive is still under construction, according to Samuel M. Vauclain, President of the Baldwin Locomotive Works. The engine itself has been completed and is turning over under a light load, but it will be sixty days before it will be put on a real load test, he said.

"When the locomotive is finished," he continued, "we may have learned enough about locomotives of this type to rebuild it and improve it. So far, tests of the engine itself without a load have been satisfactory."

Gilding the Shine

LIKE the lily, our shoes may be gilded, or rather given a super-polish by the aid of a bone of a deer. In England, the butler, or the second man, or the chauffeur, or the gardener, or whoever attends to the shoes, gives an extra burnish to the shoes by the aid of a deer bone, and now we have them here. You can take one home for about one dollar and seventy-five cents—up. The bones are highly polished and will make a great addition to the blacking box. There is no great prospect, however, of their ever becoming very popular in this country.

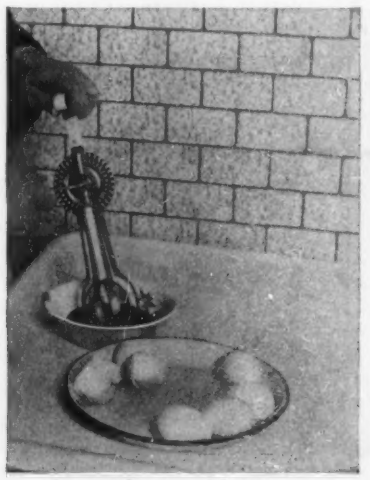


A deer bone finishes the shine

A Gearless Egg Beater

EGG beaters never had very much in the line of gears, except our old "Dover" beater with cast gears which made all our omelettes for about sixteen years and, finally, went down the dumbwaiter full of old age, but shy of teeth. The egg beater illustrated has little punched-up knobs which take the place of gears and mesh perfectly. It runs more easily than any beater of our acquaintance.

The egg beater is enameled in blue and a blue wire hook is provided.



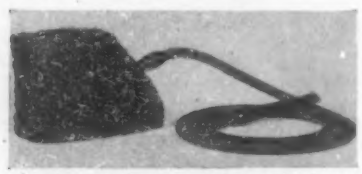
An egg beater without gears

Shock-absorbing springs are used in this kiln ring gun

A "Kiln Ring" Gun

FIRST, we must tell what a "Kiln Ring" is. In the manufacture of cement in the kiln, a cement kiln in operation carries a coating of fused clinker for quite a distance back from the burning end. A clinker ring is simply a heavy coating which builds up from the sides in a ring formation, decreasing the effective diameter of the kiln at the point of operation. These rings are broken in several ways; by breaking with a bar, or by a jet of water. Now, however, a new gun of heavy construction with a one-inch bore is employed.

The gun is attached to an "I" beam on the head of the kiln. The gun is sighted on the offending ring and fired rapidly. Within three or four minutes a groove or "key" is cut through the ring. The time needed for stopping the kiln and doing the shooting is about five to eight minutes.



A pipe that may be smoked lying down

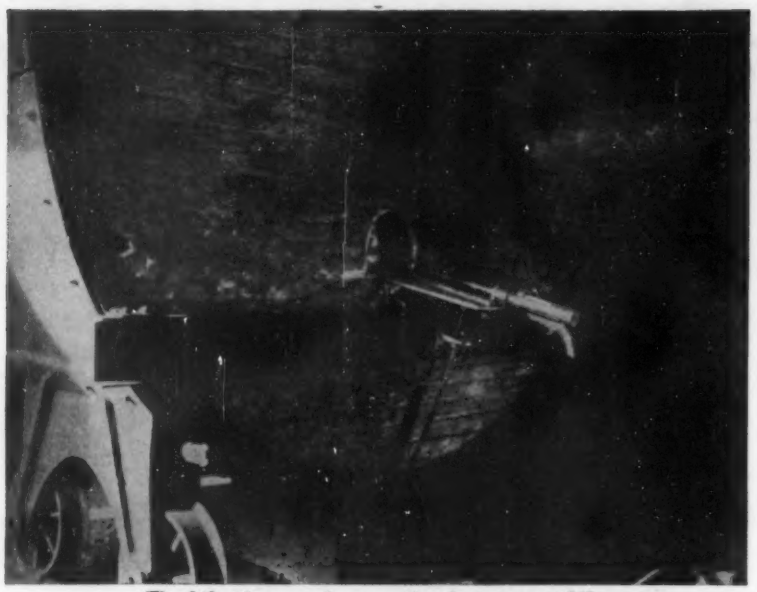
The Orlick Block Pipe

IT looks like an Oriental's pipe—but it isn't. It is just an original introduction by a famous London maker who can appreciate many phases of a smoker's requirements. The "block" pipe, hand cut from a solid block of high-grade Corsican Bruyère root, already broken in by a special baking process, is sweet from the first pipeful. Three feet six inches of tubing and a massive bowl assure coolness.

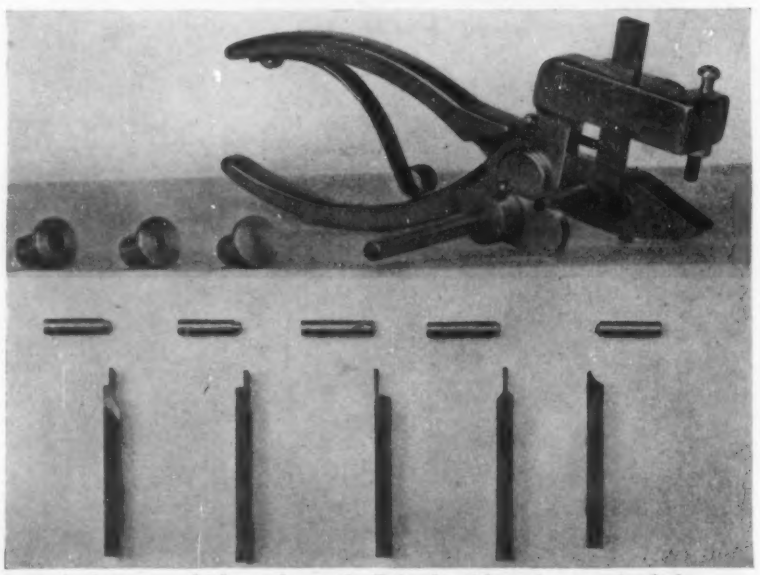
A Handy Pin Cutter

WHERE the number of pieces to be machined does not permit the setting up of an automatic screw machine, this tool can be used efficiently with a cheap speed lathe and, where the length of the pin is one-half inch or less depending on the diameter, a considerable number of pieces may be cut off at one chucking. The illustration shows that various kinds of pins can be made; for example, straight cut off, round end, or shoulder pins.

A foreign member of the can-opener family



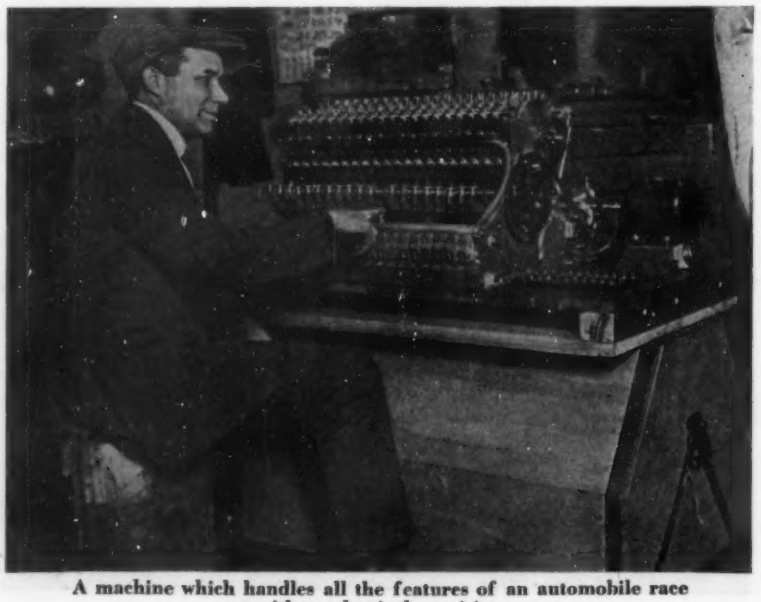
The kiln ring gun in operation in a cement kiln



A pin cutter which can be used efficiently with an inexpensive lathe

Machine that Will Completely Score Automobile Races

A NEW invention recently perfected by August Duesenberg, famous head of the racing team bearing his name and designer of motor cars, completely scores an automobile race without possibility of error through the usual human frailties. The machine is not large, but handles all the features of a race with mechanical certainty, and provides a printed record which is a complete analysis of all features of the contest. The picture shows the front of the device with the inventor demonstrating how it works.



A machine which handles all the features of an automobile race with mechanical precision

A boxwood plate scraper from England

A Novel Plate Scraper

SCRAPING scraps of food from plates is a disagreeable operation, at best, but will be facilitated by the pretty little boxwood paddle which comes from England, and does the work effectively. The grain of boxwood is so dense it does not absorb even moisture, so the paddle is easily kept clean.

A set of six serviceable wrenches

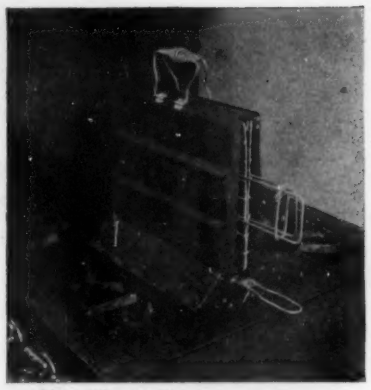
Handy Wrench Set

SIX serviceable wrenches, answering a multitude of purposes are illustrated. All wrenches are assembled on a convenient ring, and yet can be detached for use quickly. They fit nuts from five-sixteenths inch to five-eighths inch hexagon or square. They will be found convenient in the home for the vacuum cleaner, radio set, in the garage or even in the office.

Lemon Shreds for the Prunes

WE all know how prunes are improved with a little lemon peel shreds cooked with them. The little instrument illustrated quickly converts the entire peel of a lemon into shreds, leaving the lemon proper for other uses. The cutter consists of fine holes through which the outer skin of the lemon is forced.

Cutter for shredding lemon peel



The "broilet" saves your gas

The "Broilet"—a Vertical Broiler for the Top of the Stove

THIS device was shown in these columns some two years ago but we had no opportunity of testing it until recently, and it is so good that we think it worth while to present it again so that our new readers may know about it. The "broilet" broils on both sides, on the top of the stove too, without heating up the oven and grill. The construction is clearly shown by the two engravings. The steak, chop, fish or chicken is secured in the grid which is hooked on the fixed half, and the side which lets down is closed and the cooking begins. There is a drip-pan in the bottom which is filled with water and makes the gravy. The steam generated is sufficient to baste the meat.

Six-spindle Bolt Threader

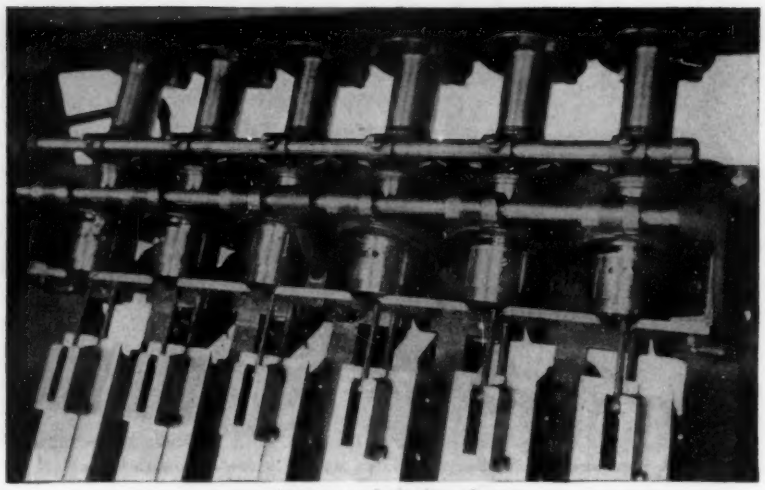
THE bolt threader illustrated can take care of square, hexagonal or clipped heads, or square or oval shanks. The operator loads and knocks out the bolts, but all the other operations are automatic.

Twelve synchronized cams are employed, six to start the bolts and six to close the die heads, but as these cams act only against counterweights, an imperfectly entered bolt cannot break chasers nor can a clogged die head be strained. The action of the cams against the counterweights and of the counterweights against the working parts of the machine, is unique, and the perfection of the design has been clearly demonstrated. The lower set of counterweights starts the bolts and the upper set closes the die heads.

Automatic Arc-welding Travel Carriage

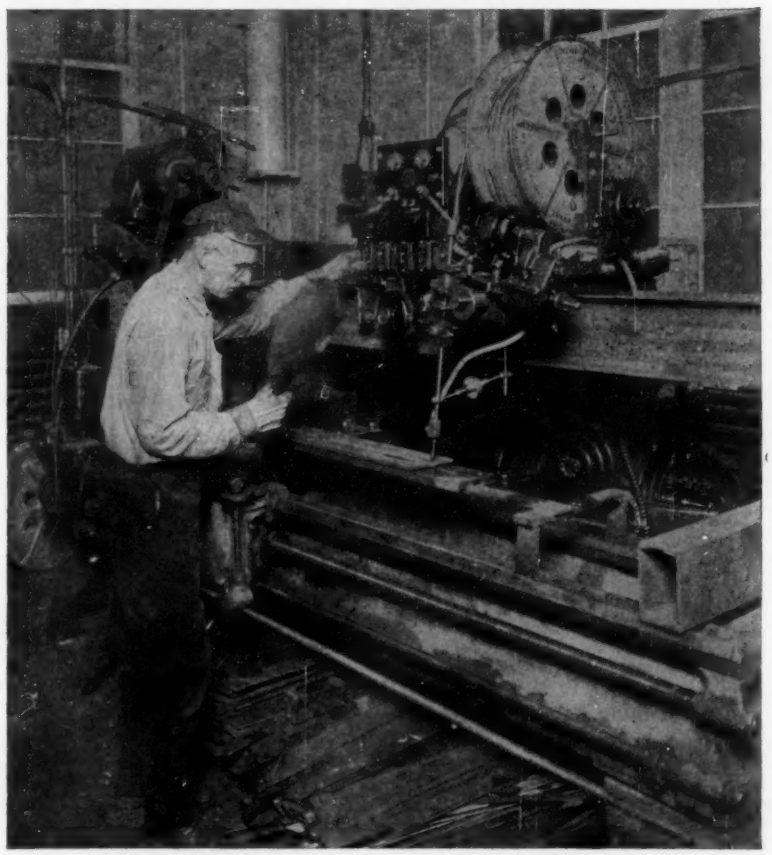
FOR the purpose of simplifying the welding process in production work where similar welds are made repeatedly on similar articles, a travel carriage has been developed for the automatic arc welding of straight seams. This carriage is a self-contained unit. It consists of an automatic welding head, necessary control, travel motor and wire reel support, all mounted on a suitable framework and provided with wheels for rolling along a track. The welding head and control are mounted on the apron of the carriage and feed the electrode wire from a reel to the arc. This reel is carried by supports attached to the carriage frame.

In operation, the travel carriage is so controlled electrically by means of push buttons that, once the work is set up ready for welding, the operator may throw the system to automatic position, thus confining the control of both welding head and travel motor to one push button. Control of the welding head and travel motor is so interlocked that, when the starting button is pushed, the arc is automatically established simultaneously with the starting of the travel motor.



Automatic bolt threader

Another view of the "broilet"



A machine for automatically welding straight seams

Getting the Dust Off

THE device shown here is a small, compact, light weight, complete suction cleaner adaptable to all kinds of cleaning, other than the floor. It is a machine designed principally to clean in the hard-to-get-at-places.

It is extremely easy to handle because of its light weight—weighing only 5½ pounds. It is equipped with a "D" handle placed in such a way that the machine balances perfectly when in use.

Our illustrations show three applications, in a store, in a barber shop and in a stable where it takes the place of currycomb and the horse brush.

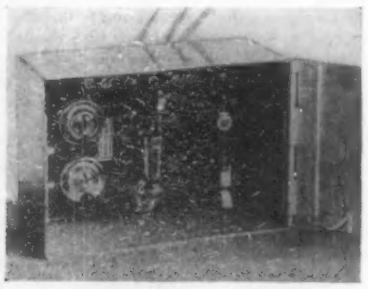
An extremely portable vacuum cleaner which has many uses. Left, cleaning goods at the tailors. Middle, earning his tip. Right, exit the currycomb

A marcel waver for home use

Marcel Waving in the Home

THIS device comes from Germany and has the advantage that it can be worked without requiring the services of a professional barber. It is a very simple iron, and one that you yourself could use with the utmost ease. The illustration shows the method of application, using a comb and the device.

If we analyze a marcel wave we find that it is produced by making two waves in opposite directions. This is accomplished by the lever which swings out and manipulates the curling iron to a new position.



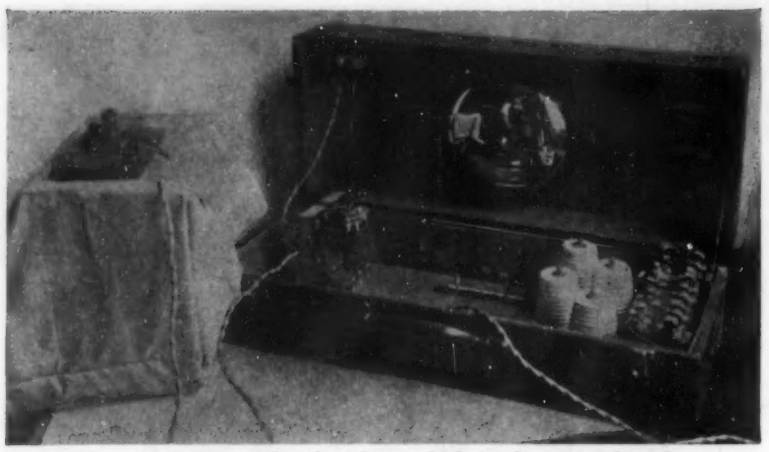
A mercury contact alarm for automobiles

Foiling the Auto Thief

THIS is a small edition of the burglar alarm shown elsewhere on this page, and is a most ingenious device for protecting one's automobile, truck, or delivery wagon against theft.

In order to sound the alarm the thief has to enter the automobile. There is an adjustable mercury contact which is capable of being set to any desired sensitiveness. In delivery wagons a wire gives the alarm if the door is opened by unauthorized persons. Goods in open trucks can be protected by this wire which will give the alarm if cut or disturbed.

Four-color magazine pencil



A mercury contact burglar alarm which is always on the job

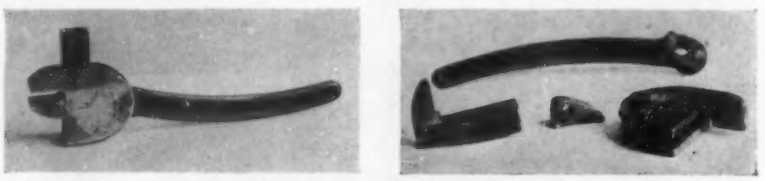
A Four-Color Pencil

NEARLY everyone has felt the necessity of having colored pencils for certain annotations. With the pencil shown there are four magazines for four different colors. Any one of these can be thrown into use by the simple operation of withdrawing the projection lead into its own magazine and then turning the cap on end so that a new color is brought into use. The magazines are recharged by removing the bottom of the pencils.

A Ratchet Wrench With Few Moving Parts

IN this ratchet wrench there are few moving parts and nothing to get out of order. We have "dissected" it to show the construction.

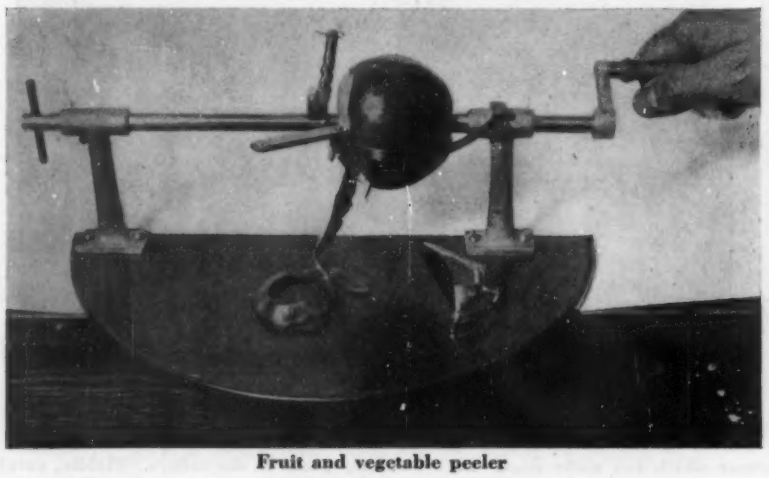
The wrench is adjusted to the nut or other object by pressing the jaw apart. A pull on the handle does the rest.



Automatic ratchet wrench

An Adjustable Peeler for Fruits

AN apple, pear, peach, lemon or potato peeler comes from Germany. No doubt it will be a welcome addition to the kitchen of the housewife who ordinarily has had to use a knife for peeling. The peeler illustrated adjusts itself to the contour of the fruit or vegetable being peeled. This is accomplished by the flexible band that guides the knife. With the right hand the fruit or vegetable is turned, and the left hand holds the knife steadily while it is guided by the flexible spring. Another knife is shown; the base of this is used for cutting up the fruit to the core.



Fruit and vegetable peeler

Keeping the Burglar Guessing

THE poor burglar that bridges the contacts, short circuits the line, or cuts through the conducting wires or destroys the contact apparatus has indeed fallen on evil days. The device comes from Austria. For purposes of convenience it is shown in a suitcase, but, of course, the alarm mechanism may be put around or inside any property, safe, vault or closet.

The quicksilver contact is shown at the left. It consists of a delicate mercury contact which responds quickly to any displacement. Any interruption or absence of the electric current immediately causes a storage battery, which is in a protected position, to be automatically switched on, so that the apparatus is ready to give the alarm.

The alarm bell or siren is shown on the cover of the suitcase, but could be located anywhere.

The device also gives an alarm if there is a fire.

Some New Elastic Snap Hooks That Have Considerable Merit

THESE hooks stay put. The main feature consists of a washer which throws forward the snap hook away from the wood, by which a springing effect is obtained. The other feature is an indentation on the hook it self so that when it engages a screw, hook or nail it remains firmly in position. Wire staples are made on the same plan. One is shown on the white background. In the right-hand corner is a hook especially adapted for automobiles.

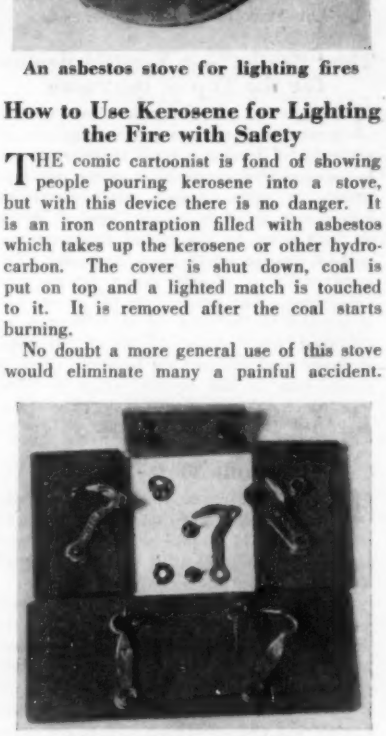
It employs the same principle as that of the wire staples.

An asbestos stove for lighting fires

How to Use Kerosene for Lighting the Fire with Safety

THE comic cartoonist is fond of showing people pouring kerosene into a stove, but with this device there is no danger. It is an iron contraption filled with asbestos which takes up the kerosene or other hydrocarbon. The cover is shut down, coal is put on top and a lighted match is touched to it. It is removed after the coal starts burning.

No doubt a more general use of this stove would eliminate many a painful accident.

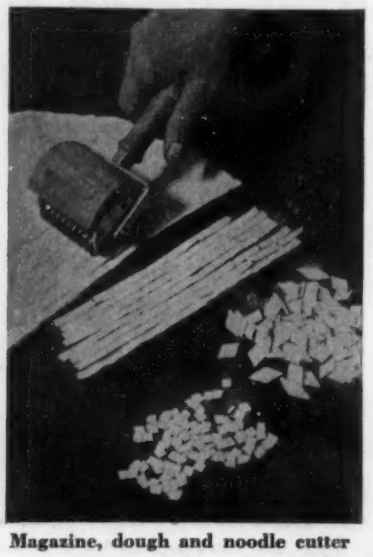


Elastic safety snap hooks

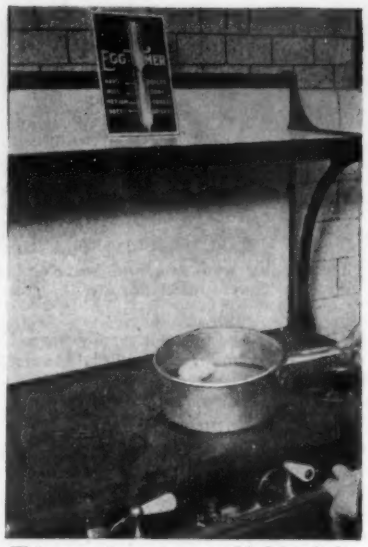
New Dough Cutter Simplifies the Making of Noodles

THE American cook rarely makes her own noodles but she could readily do so if she had one of these cutters. The action is shown in the engraving which illustrates the making of strips. These strips may be cut into squares by a second cutting. There are six sets of knives which can be thrown into gear as desired, thus enabling any width of dough to be cut.

With the aid of this device half of the trouble in making home-made noodles would be eliminated.



Magazine, dough and noodle cutter



This egg timer is our old friend the hour glass

Varying Egg Timer

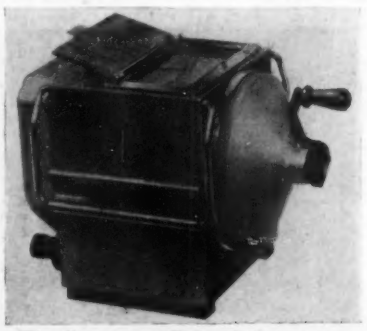
IN a household, where nearly everyone has a different time he desires his eggs boiled, the only way to preserve the peace of the breakfast table is to use an egg timer. Mark J. T's initials opposite his one minute, and Marjorie's opposite her two minute eggs, and so on—and you'll get a lot of credit for your memory.

Auto-Irrigated Fern

AUTO - IRRIGATION maintaining soil moisture content of a pot with a Boston fern was a feature of the Washington meeting of the American Association for the Advancement of Science. As the plant loses water by transpiration, the roots absorb more water from the soil. As the soil becomes drier it absorbs water from the reservoir bottle. Air to replace the water lost from the reservoir comes as bubbles through an oblique tube of glycerine, where the bubbling rate may be observed. About fifty bubbles pass for each cubic centimeter of water that leaves the reservoir.

The entire system is mounted on a balance and the actual loss of water through transpiration by the fern may be authoritatively determined by adjusting and reading the balance from time to time.

The auto-irrigated fern was exhibited at the Washington meeting of the American Association for the Advancement of Science



The "super-meg" insulation tester

Multiple Grater for Many Uses

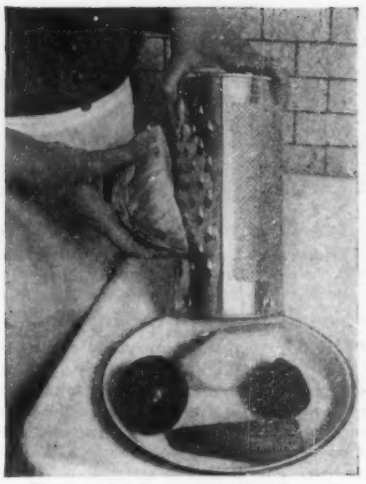
THIS circular grater is of great value in the kitchen owing to its shredding and grating surfaces. It is a time saver and is inexpensive. The illustration renders a description superfluous.

The "Meg" Insulation Tester

THE "Meg" is a small sized "Megger" Testing Set and consists of a direct reading ohmmeter and a hand-driven direct current generator which supplies 500 volts for the test. The ohmmeter reads directly in ohms and megohms on a scale having a range from 0 to 100 megohms (100,000,000 ohms.)

The instrument stands 6¼ inches high and weighs 6¾ pounds.

The insulation test is of value at installation of electrical equipment, at time of breakdown or repair and periodically while the apparatus is in service.



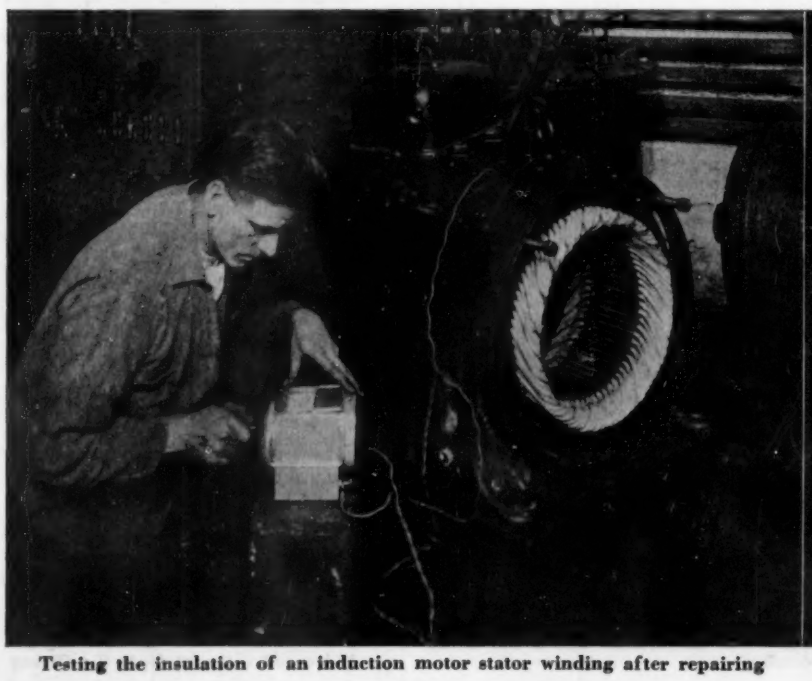
This multiple grater shreds and grates almost anything

The "Meg" Ohmmeter

THIS instrument is used largely by manufacturers of radio apparatus for measuring grid leaks and for testing the insulation resistance of fixed condensers, transformers and other parts.

To operate the "Meg" Ohmmeter the + and — binding posts are connected to house voltage (direct current), a radio "B" battery or to a rectifier of proper voltage. The resistance to be measured is connected to the two upper binding posts and the value of the resistance is then read directly on the scale.

"Meg" ohmmeter. A direct reading instrument for the measurement of high resistance



Testing the insulation of an induction motor stator winding after repairing

Making "meg" tests of direct current armatures in a repair shop

These metal grippers hold the overshoes in place

Keeps Overshoes On in the Mud

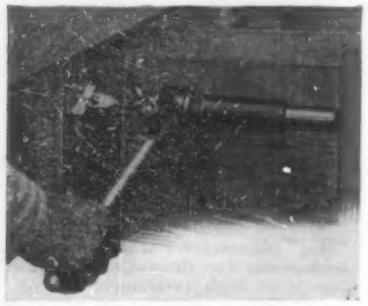
THOSE who traverse muddy roads will be interested in a recently patented device for preventing overshoes from being pulled off by deep mud. It is in the shape of two metal grippers that clamp the overshoe to the shoe itself. For a high shoe, there is a hook that is attached to the top of the shoe and extends down to hold the gripping jaws. The jaws are movable so that too much wear will not be brought to bear on one spot.

Portable Mill Works

MANY times in the past we have all wished for a woodworking machine combining many of the features of the mill works, so portable, well balanced and flexible that we could take it to where heavy timbers lie and frame them to our heart's content while they lay where gravity held them. Butchers are planing their chopping blocks as they stand. Tank and vat makers are framing their heavy timbers as they lie on benches; cutting, splining, boring and gaining on timbers as thick as twelve inches is all done as the timbers lie.

A Ratchet Boring Tool Is a Labor-saving Device

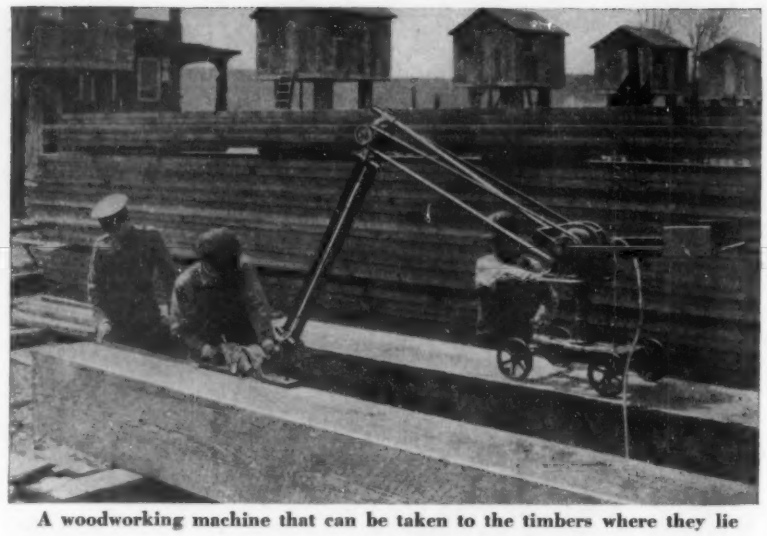
THIS device will bore holes through joists or other parallel timbers and takes the place of a saw, or mallet and chisel,



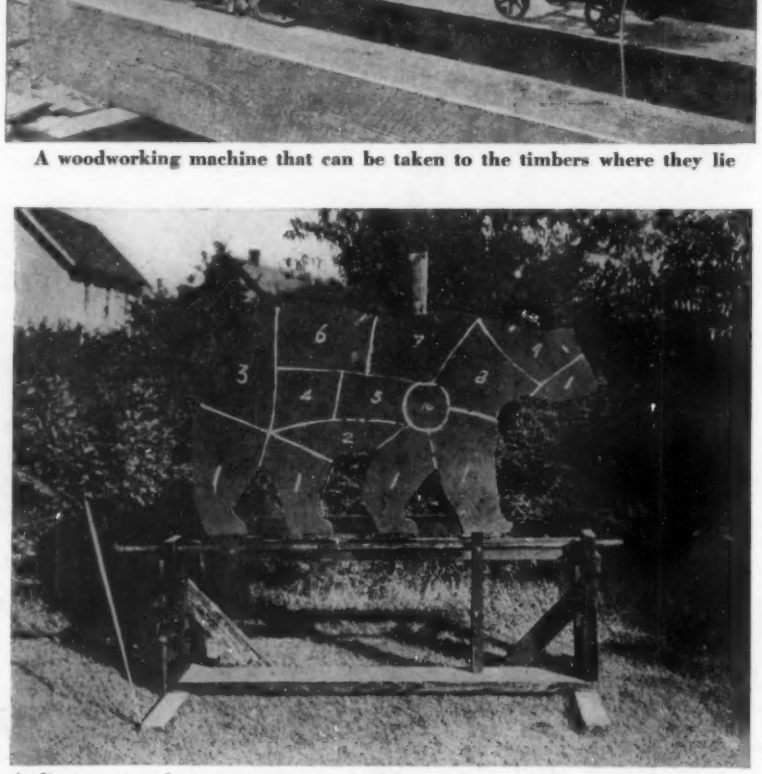
An adjustable ratchet boring tool

which has heretofore been necessary in connection with piping jobs. It is adjustable for use between joists spaced at different widths, and after being placed in position,

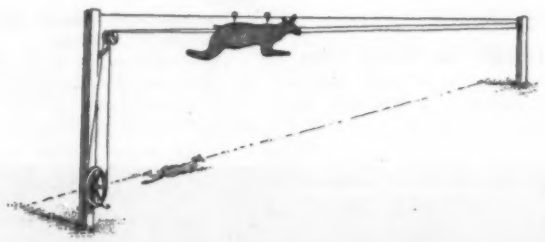
A message clip that is attached to the telephone

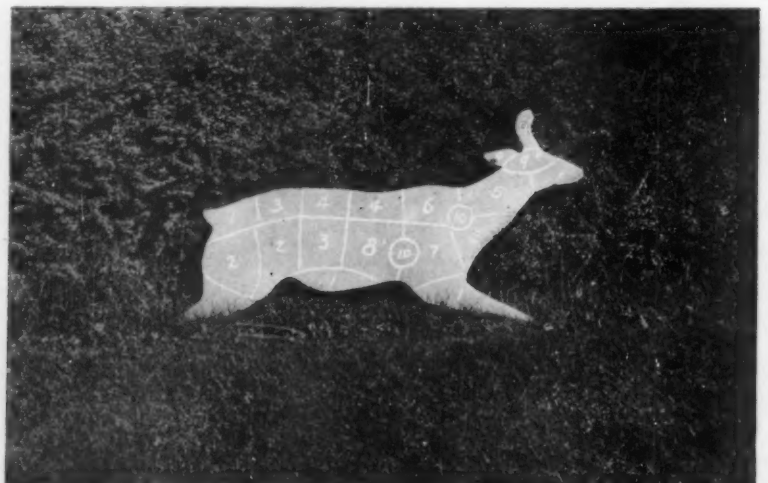


A woodworking machine that can be taken to the timbers where they lie



A disappearing bear target is operated by a wire attached to the lever seen at the left of the illustration





For this photograph the deer model was simply set up against a hedge. It gives an idea of size and numbering. The illustration above shows the mechanism

This sealer moistens and seals sixty envelopes a minute

feeds itself. The operator merely works the ratchet back and forth until the hole is bored.

Tongue Saver

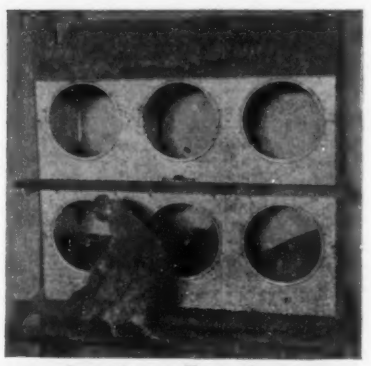
THE envelope sealer illustrated moistens and seals sixty envelopes a minute. Its handle is a water tank, and holds enough to seal 1200 envelopes. A sealing finger locks the envelope by ironing the flap, moistening is done by a felt tongue. In the end of the handle is a stopper cap which is easily removed for filling.

Saves Lost Messages

A TELEPHONE clip that insures your getting that telephone message is illustrated here. It snaps on as shown and does not interfere with telephone service in any way.

A Sanitary House for Mrs. Hen

MRS. HEN has a new sanitary house. It is an all-metal nest built of steel sheets with a top which is inclined and which prevents her roosting where she should not. The backs of these modern nests are open, and when swung slightly outward from the wall and given a slight tap the straw slides out and new straw can replace it.



A sanitary all-metal nest

A Teapot from the Orient

A LARGE importer of Oriental goods has just introduced a new teapot of pleasing design, resting on an ornamental metal base, which is decoratively cut away to admit of a lamp being inserted at several places.

A decorative teapot from the Orient

Recently Patented Inventions

As a convenience to our readers, we will supply copies of any patents listed herein for 15 cents each. The official printed copies of patents include complete descriptions and drawings of the inventions disclosed. State the patent number to insure receipt of the desired patent copy.

Of General Interest

KITCHEN SINK.—Having a deep portion or well in which dishes can be washed, and a drain board for scalding or drying. Patent 1522045. L. C. Burton, 4528 Melbourne Ave., Hollywood, Calif.

THEATRE STRUCTURE—Constructed with a view to the convenient seating and emptying of the house, and the preservation of the patrons' eyesight. Patent 1523944. C. E. Fowler, 25 Church St., New York, N. Y.

BURIAL VAULT—In which bodies may be placed and protected against seepage, or the action of the elements. Patent 1523851. H. H. Althoff, 1965 Metropolitan Ave., Middle Village, L. I., N. Y.

GUARD FOR KNITTING NEEDLES—Which may be readily attached adjacent the end to prevent the accidental displacement of stitches. Patent 1523918. D. Traum, c/o Dritz Traum Co., 27 E. 22nd St., New York, N. Y.

ARTIFICIAL FLY—For fishing, closely resembling an insect, yet strongly constructed so that it may be repeatedly used. Patent 1523895. F. B. Pott, 530 E. Cedar St., Missoula, Mont.

HOLDING DEVICE FOR ANIMAL TRAPS—Adapted to prevent the return to land of an animal caught adjacent the edge of a body of water. Patent 1523690. E. M. Horton, Box 581, Ketchikan, Territory of Alaska.

DESIGN DEVELOPMENT—Of the type known as kaleidoscopes used in design-generation of textile designing, etc. Patent 1523992. W. C. Hadley, c/o Genl. H. S. Borden, 90 Worth St., New York, N. Y.

BULL ROPE—Wherein "rope mill waste" is used as a core for the rope structure giving the necessary bulk. Patent 1523940. W. L. Faust, c/o Whitlock Cordage Co., P. O. Box 58, Bergen Sta., Jersey City, N. J.

OIL SPOUT—In which the spout and air vent are made from a single piece of metal. Patent 1523696. D. D. Lewis, 110 W. South St., Kalamazoo, Mich.

PROTECTING FUNNEL FOR FRUIT JARS AND THE LIKE—Which will prevent the cracking of glass jars upon pouring in scalding water or hot fruit. Patent 1522167. C. W. Young, 682 E. Julian St., San Jose, Calif.

INNER SEAL FOR CASKETS—Providing a means for mounting a glass panel on the metal frame members of the seal. Patent 1523699. E. Lunsford, 36 Altoona Place, Atlanta, Ga.

FOLDING STAND—For an ironing board, constructed wholly of metal, and easily attachable to a table. Patent 1523960. C. M. Harbison and T. V. Smith, 11127 112th St., Richmond Hill, L. I., N. Y.

DOUBLE VANITY CASE.—With rotary interior closure, for covering the rouge compact compartment and with sifter means for the powder compartment. Patent 1524559. M. Kline, c/o Superior Novelty Mfg. Co., 3 W. 29th St., New York, N. Y.

Hardware and Tools

SANDPAPERING AND RUBBING HAND BLOCK.—Whereby sandpaper or other material may be readily applied and firmly held during a polishing operation. Patent 1522,459. J. Jackowitz, 656 Metropolitan Ave., Brooklyn, N. Y.

COMBINATION TOOL.—In which leakage from an air chuck is prevented, while a connection of the chuck with the air nozzle may be readily effected. Patent 1522369. F. I. Jarden, c/o Jarden Mfg. Co., Hastings, Neb.

DRILL-BIT CONSTRUCTION.—Whereby a drill bit can be easily, quickly and firmly inserted in a drill shank, or removed therefrom. Patent 1523253. J. J. Brossoit, 1024 Windson, Salt Lake City, Utah.

RAZOR HONE AND METHOD OF FORMING THE SAME.—From cork pine or soft wood impregnated with rosaline oil and paraffine wax, and then baked. Patent 1522668. J. S. Benson, c/o Lutz & Gordon, Beloit, Kans.

ADJUSTABLE CLAMPING MEMBER—Comprising a threaded bolt, a thumb nut, and a lever adjustable to various thicknesses of superimposed frame members. Patent 1523663. J. A. Slama, 613 Barker St., Racine, Wis.

TWISTING TOOL—Designed to allow of the twisting or straightening out of connecting rods used in gasoline engines. Patent 1522083. A. Stansrud, 257 Lester Ave., Oakland, Calif.

POCKET KNIFE—With locking means which will automatically lock the blade in open or closed position. Patent 1521778. R. L. McLay, Sacramento, Calif.

CASTER.—Adapted to sustain a relatively heavy load without any binding action on the movable parts. Patent 1524424. H. D. Darlington, R.R. No. 2, Dayton, Ohio.

REVERSIBLE SNOW PLOW.—For removing snow from a street, the blade being adjusted from a point along the handle, and firmly held. Patent 1524639. F. M. Grady, 520 Dakota St., Butte, Mont.

Heating and Lighting

APPARATUS FOR LIGHTING AND EXTINGUISHING GAS BURNERS FROM A DISTANCE.—By means of a lever and counter-weight system which acts in opposition to the pressure of the gas. Patent 1523271. P. Minaux, c/o Office Picard, 97 Rue St. Lazare, Paris, France.

BURNER—Adapted for use in industrial furnaces as in a country home where gas or electricity is not available. Patent 1523876. A. Kais, 19 Monterey St., Highland Park, Mich.

BAKER'S OVEN.—Which includes a plurality of oven units in which various degrees of heat are obtained. Patent 1524541. J. B. De Keir, 1336 2nd Ave., New York, N. Y.

Machines and Mechanical Devices

AUTOMATIC MACHINE FOR CASTING STEREOPLATES.—Which prevents emptying the pot, by cutting off the flow of metal, if the form is prevented from reaching its proper casting position. Patent 1520626. C. Winkler, c/o Winkler, Fallert Co., Berne, Switzerland.

SELF-CLOSING VALVE.—For use in oil wells and the like, automatically preventing the oil escaping beyond the control of the operator. Patent 1520377. T. E. Washburn, Box 1041, Coalinga, Calif.

STREET SWEEPER.—Having a rotary broom and means for applying a liquid simultaneously with the sweeping operation. Patent 1520315. J. H. Stewart, c/o W. E. Richardson, 406 Independent Life Bldg., Nashville, Tenn.

LIQUID-DISPENSING DEVICE.—Which affords facilities for dispensing predetermined quantities without permitting air to mingle with the liquid. Patent 1521543. H. H. Johnson, 304 13th St., S. W., Washington, D. C.

SWAB.—Whereby obstructions surrounding the perforated liner of a well will be broken down and removed. Patent 1520400. A. Boynton, City National Bank Bldg., San Antonio, Texas.

SAND PUMP.—Having means for conveniently connecting a trap thereto, for the recovery of various articles dropped in a well. Patent 1520803. C. H. Brown, c/o Brown Welding & Machine Co., Breckenridge, Texas.

APPARATUS FOR PRINTING PHOTOGRAPHIC PRINTS FROM NEGATIVES.—In which the intensity of light may be varied according to the density of the negative to be printed. Patent 1521399. I. D. Sharp, c/o Sharp & Co., Nicholasville, Ky.

MOLD-HANDLING MECHANISM FOR TIRE-CURING APPARATUS.—So arranged that it will receive the cured tire casings from a cylinder, dispose of them, and place uncured tire casings in the vacant cylinder. Patent 1522446. R. DeW. Haas, 506 Hillcrest Ave., Inglewood, Calif.

ROAD DRAG.—Adapted for use with road making machines, to be drawn over an uneven road effecting a leveling of the surface. Patent 1522164. G. E. Wickens, Avon, S. D.

PUMP.—For use in mines and places where the power unit cannot be conveniently placed close to the pumping mechanism. Patent 1521718. J. L. Shafer, c/o Gas Boiler & Machine Co., Joplin, Miss.

WEIGHING SCOOP.—Which overcomes the necessity of pouring the contents of the scoop into a separate scale. Patent 1522316. C. Nauck, c/o Gardner & Brown, Attys., Gulfport, Miss.

OIL WELL PUMP.—Providing increased capacity for a given size of tubing, and a sand arrester. Patent 1522075. J. Penrod and R. D. Thompson, 617 Commercial Bldg., Box 97, Okmulgee, Okla.

EXCAVATING MACHINE.—Which performs three distinct and simultaneous actions, in the operation of digging, lifting out, and dumping. Patent 1522078. C. F. Rayburn, Moscow, Idaho.

MACHINE FOR CUTTING STONE.—Having cutters in the form of shafts and employing means for rotating these shafts with an axial movement. Patent 1522057. J. C. Hightower, College Park, Ga.

PIPE-CLEANING MACHINE.—For thoroughly removing the formation of rust, dirt, scale, etc., without injury to the pipe. Patent 1521735. J. Vlahos, General Delivery, Petaluma, Calif.

MAGNETIC SEPARATOR.—Which separates magnetic substances from non-magnetic substances by the application of magnetic force. Patent 1522343. C. Thom, c/o H. J. Hull, Atty., Wallace, Idaho.

SNOW REMOVER.—In which the snow is directed upwardly and laterally, for discharge into a vehicle, or at the road side. Patent 1522340. W. L. Stadig, Soldier's Pond, Maine.

ELECTROPLATING APPARATUS.—Providing a simplified mechanical device whereby a more uniform plating action is insured. Patent 1522422. J. T. Daniels, 188 Lincoln Ave., Newark, N. J.

APPARATUS FOR MANUFACTURING ALL KINDS OF HOLLOW CYLINDRICAL TUBES AND PIPES.—Or any other circular piece made from plastic material with or without metallic reinforcement. Patent 1523226. V. Maggio, c/o Lind & Cie., 25 de Mayo 35, Buenos Aires, Argentina.

PULLEY WITH VARIABLE DIAMETER—Having a number of segments adapted to be moved towards and away from the shaft upon which the pulley is mounted. Patent 1523241. N. A. W. Backman, Bondegaten 61-63, Stockholm, Sweden.

LOOM-BEAM BEARING AND LOCK.—Which will avoid the necessity of the removal of loom side frames when worn. Patent 1523328. O. C Wilson, c/o E. J.. Dickert, The Mollohan Mfg. Co., Newberry, S. C.

FLOAT VALVE FOR FLUSH TANKS—Which is noiseless, and provided with a control which is instantaneous, as it nears closing position. Patent 1523062. J. M. Fleming, 114 W. Oliver Street, Ft. Collins, Colo.

TAKE-UP FOR KNITTING MACHINES—Providing a gripping and lever mechanism wherein the speed of take-up may be varied without changing the usual driving cam. Patent 1523915. G. C. L. Tisch, c/o Tisch Knitting Machine Co., 452 Spring St., Elizabeth, N. J.

APPARATUS FOR TREATING BRIQUETTES—In such manner that the binder will be dried and carbonized to make the coal waterproof. Patent 1523971. C. I. Johnsen, 349 Pandifield Road, Bronxville, N. Y.

DISPENSING DEVICE FOR SEALED CONTAINERS—Comprising a pouring spout with puncturing implement, for forming an opening to receive the spout, adjacent the periphery of a can. Patent 1523911. A. Staeheli, 207 W. 85th St., New York, N. Y.

CALCULATING DEVICE—Having removable dials upon which the mathematical scales are imprinted, so that different scales may be substituted. Patent 1523680. J. G. Zollman, 5346 Greenwood Ave., Chicago, Ill.

SEWING-MACHINE ATTACHMENT.—For sewing on snap fasteners, and for feeding and properly positioning the same to the sewing mechanism. Patent 1524139. H. C. Klagges, 59 Slocum St., Brooklyn, N. Y.

CONTROLLING MEANS FOR FRICTION HOISTING MACHINES.—Which includes a plurality of rock levers operatively connected by intermeshing gears and a reduced space to accommodate the machine. Patent 1524625. V. W. Mason, 2 Lafayette St., Providence, R. I.

CASING WASHER.—Adapted to be readily inserted into a well casing, or withdrawn therefrom, to effectively apply a cleaning fluid. Patent 1524592. L. E. Stephens, Box H, Fellows, Calif.

SMOKEHOUSE.—In which a cage can be supported and slowly revolved so as to insure a perfect smoking of the articles therein. Patent 1524533. L. Brand, c/o Brand & Sons, 1st Ave. and 49th St., New York, N. Y.

LEVEL MAINTAINER FOR SHACKLE ROD LINES.—Maintaining the shackle rods at a level that will not exert injurious forces on the power house or bullpen. Patent 1524,383. A. Boynton, 1019 City National Bank Bldg., San Antonio, Texas.

PUMP.—Which makes use of two plungers mounted on a working barrel, whereby a larger quantity of water may be pumped. Patent 1524021. A. D. Cook, c/o F. J. Cook, 337 Ridge Ave., Lawrenceburg, Ind.

Medical Devices

OBSTETRICAL DEVICE.—For assisting the patient by providing a suitable rest, and means for giving it a vibratory motion. Patent 1521790. C. A. Prescott, Hudson Falls, N. Y.

DENTAL INSTRUMENT—Adapted for use in removing crowns of gold or gold crown abutment bridge irrespective of the position in the patient's mouth. Patent 1522916. J. J. Siuda, and S. M. Dorzewski, 2660 E. Allegheny Ave., Philadelphia, Pa.

Prime Movers and Their Accessories

INTERNAL-COMBUSTION-MOTOR PISTON.—In which the use of split packing rings may be dispensed with, and a single ring of continuous type employed. Patent 1518048. D. Goughey, 426 W. 42nd St., New York, N. Y.

LIQUID FUEL DELIVERY SYSTEM FOR INTERNAL-COMBUSTION ENGINES.—Adopted to be utilized for insuring the delivery of liquid fuel to the carburetor. Patent 1518066. C. Hammond, c/o E. A. Ruegsegger, Atty., Boyne City, Mich.

IGNITION TIMER.—For internal combustion engines, particularly adapted for use on Ford motor vehicles. Patent 1519566. A. W. Tiefanthaler, Anaconda, Mont.

MEANS FOR STARTING INTERNAL-COMBUSTION ENGINES.—Comprising a pump connected with a hydrocarbon vaporizer for drawing in a supply of hydrocarbon to the inlet pipes. Patent 1520552. A. J. Adams, The Cottage, Heywood, near Westbury, England.

COMBINED ATOMIZER AND VAPORIZER FOR OIL ENGINES.—Which uniformly distributes the fuel vapor throughout the explosion end of the cylinder. Patent 1520153. A. C. Smith, c/o Fernholtz Machine Co., 2053 E. 38th St., Los Angeles, Calif.

MUFFLER FOR INTERNAL-COMBUSTION ENGINES.—Which freely permits the escape of gases from the exhaust to the atmosphere. Patent 1521074. S. L. Carr, 545 Kingsley Ave., Palo Alto, Calif.

TURBINE.—Engine in which there are a plurality of impelling elements simultaneously operated. Patent 1522487. L. E. Gommer, 136 Jackson St., Pontiac, Mich.

PISTON AND CONNECTING-ROD CONSTRUCTION.—Each being indispensable to the other and operating to produce an efficient lubrication of the piston as it reciprocates. Patent 1521515. J. E. Erskin, 1608 E. Duval St., Jacksonville, Fla.

INTERNAL-COMBUSTION MOTOR.—Having a cylinder head carrying a rotary valve, interchangeable with heads of motors of any type. Patent 1521842. W. D. Sprague and J. G. Elkin, 184 Hudson St., New York, N. Y.

Railways and Their Accessories

MINE SKIP — Provided with an automatically controlled brake mechanism operating on the severance of the draft connections to lock the skip. Patent 1513296. E. C. Thorne, 143 Donnelly St., Turffontein, Transvaal, South Africa.

LOCK FOR HOPPER-CAR DOORS—Particularly designed for the doors which close the hopper bottoms of gondola cars. Patent 1517005. C. D. Hobb, Box 4, Middlesboro, Ky.

MOUNTING FOR CAR-WHEEL JACKS.—Which affords facilities for releasably holding a car wheel against movement relatively to a supporting rail. Patent 1517769. P. E. Valentine, R. No. 1, Princeton, Ky.

ARCH-FLUE CLAMP.—Adapted for locomotive engines and similar places, whereby the flues are locked in position temporarily until they are properly expanded. Patent 1518,038. S. J. Wilson, 8 Otis St., Somerville, Mass.

CAR REPLACER.—Easily moved to and from the rails of a track to accurately guide a derailed car onto the rails. Patent 1517,632. W. F. Jones, Dialville, Texas.

FLEXIBLE CONNECTION FOR BOILERS.—For use in locomotive steam engines, establishing communication between upper and lower parts of the water space of the boiler. Patent 1517344. L. W. Craft and J. H. Bassett, 2213 Central Ave., Kansas City, Kans.

DOLLY BAR.—Employed in mounting flexible stay bolts in the construction and repair of fire boxes of locomotive engines. Patent 1521547. H. A. Lacerda, 1296 Broadway, Watervliet, N. Y.

RAILROAD SWITCH LAMP.—Automatically producing illumination at the switch by the reflection of the usual headlight of an approaching engine. Patent 1520774. C. Scherle, 1405 Wyo St., San Antonio, Texas.

SAFETY DEVICE FOR RAILWAYS.—Providing means for automatically stopping a locomotive while running at a normal rate of speed. Patent 1522452. M. K. Healy, 2612 Ave. D, Brooklyn, N. Y.

RAILROAD SPIKE.—So constructed that when driven into tie, will enter in the manner of a screw, difficult to remove. Patent 1523195. F. S. Harrington, Sloatsburg, N. Y.

AUTOMATIC RAILROAD-CROSSING GATE.—Lowered upon the approach of a train, and raised after the last car of the train has passed. Patent 1524353. J. R. Golden, 320 Truman St., Hammond, Ind.

Pertaining to Recreation

GAME.—By means of which any ordinary card game requiring five cards to a hand, such as poker, may be played. Patent 1520,316. J. V. Stolper, 19 E. 108th St., New York, N. Y.

TOY.—Comprising an inflatable translucent body and means for illuminating the same from within. Patent 1521161. B. H. Marshall, 1733 12th St., Detroit, Mich.

BASEBALL GAME.—Providing a form of board whereby an unusually realistic game of ball can be played. Patent 1521435. E. H. Cole, 300 DeKalb Ave., Brooklyn, N. Y.

AMUSEMENT DEVICE.—Employing an inclined track and a foot rest adapted to travel along said track. Patent 1521487. G. E. Turner, Hot Springs, S. D.

COMBINED BOX AND TOY.—So constructed that it may be used for shipping goods and then cut in a certain way to produce a toy. Patent 1518981. C. A. Hammond-Knowlton, c/o The H. K. H. Silk Co., Watertown, Conn.

GOLF BALL TEE.—Designed for supporting a golf ball in a slightly elevated, or striking position, the device may be conveniently carried. Patent 1519298. J. B. De Mun, c/o De Mun Sign Co., Wilkes-Barre, Pa.

TOY.—Which is not only amusing but teaches quickness of observation and rapid movement of the hand and eyes. Patent 1519036. J. J. Schneider, 2426 Grove St., Brooklyn, N. Y.

AMUSEMENT APPARATUS.—In which a number of passenger cars are given an unusual movement, and yet, will be safe to ride upon. Patent 1520592. G. Mongillo, 43 Smith St., Derby, Conn.

GAME—A traffic game of a geographical nature presenting educational features. Patent 1522048. R. A. Creed, 357 So. 4th St., San Jose, Calif.

BASKET-BALL GOAL. — Having means whereby it may be firmly, yet detachably, supported upon a wall. Patent 1522957. B. Kennedy, c/o Ken-Wel Sporting Goods Co., Gloversville, N. Y.

GAME APPARATUS—In which a runway is provided, and marbles are rolled down the runway to accomplish a desired result. Patent 1523775. Clara A. and J. H. Howard, 141 No.. Oliver St., Los Angeles, Calif.

GAME APPARATUS.—Involving a rotating cup and game devices, the game depending upon which of the devices is first to leave the receptacle. Patent 1524378. R. F. Antes, 853 Quincy Ave., Bronx, N. Y.

Pertaining to Vehicles

SWITCH.—To be used for the purpose of sounding the horn of a motor vehicle. Patent 1519028. A. C. Gerber, 1409 W. Sixth Ave., Spokane, Wash.

ANTITHEFT DEVICE.—Providing means in connection with the intake manifold for rendering the engine inoperative. Patent 1519032. L. Kaufold, c/o Golden Eagle Hotel, San Francisco, Calif.

VALVE-ACTUATING ATTACHMENT FOR AUTOMOBILES AND THE LIKE.—Which may be moved by a hammer-like blow when slightly stuck in either open or closed position. Patent 1519517. M. K. Thayer, c/o Colorado Fluorspar Corp., Cowdrey, Colo.

COMBINED WATER GAUGE AND HEAT-INDICATING DEVICE.—For attachment to the radiator cap of an ordinary automobile. Patent 1519438. A. J. Charlton, Lowden, Iowa.

BRAKE CONSTRUCTION FOR MOTOR VEHICLES.—Having novel means for connecting the emergency lever of the vehicle with the brake pedal. Patent 1519467. J. W. Norris, 3035 S. Delaware St., Englewood, Colo.

DIRIGIBLE HEADLIGHT FOR VEHICLES.—Adapted to turn the headlights when the steering wheel is turned, and also to keep the lights in fixed position. Patent 1519437. J. M. Calkins, 509 Franklin St., Peoria, Ill.

TIRE CARRIER. — Which may be swung away from the luggage storage space, at the rear of a coupé. Patent 1519894. H. L. Adams, Hoosick, N. Y.

TIRE TOOL.—Which is strong and thoroughly practical to effect the removal or replacement of a tire. Patent 1520599. J. R. Robertson, Box 226, Archer, Fla.

WHEEL.—Of the demountable rim type, which may be quickly applied, without the use of special tools. Patent 1521691. J. W. Little, 131 Times Place, Muskogee, Okla.

DIRECTION-INDICATING SIGNAL.—Comprising a signaling arm, easily manipulated, and readily applied to a vehicle. Patent 1522414. E. M. Carr, 309 K. & P. Bldg., Indianapolis, Ind.

DRIVING MECHANISM FOR SPEEDOMETERS.—Adapted for use on Ford cars, and so designed as to be driven from the transmission. Patent 1521965. R. R. Norris, R. F. D. No. 4, Lagrange, Ind.

TRACTOR WHEEL.—Having means for clearing the mud from the lugs as the wheel goes around. Patent 1521798. W. Vavra, Schuyler, Neb.

FOOT ACCELERATOR FOR MOTOR VEHICLES.—Adapted to be readily secured in position, without any changes being required in the usual carburetor control mechanism. Patent 1523176. D. Cubbage, c/o Jas. L. Cave, Atty., Oxford Junction, Iowa.

COUPLER—For detachably connecting one or more vehicles with each other with means for readily uncoupling the same. Patent 1523309. J. B. Stewardson, R. F. D. No. 2, Colby, Kans.

DEMOUNTABLE RIM.—Having relatively few parts and which may be actuated to release or receive a pneumatic tire with minimum labor. Patent 1522806. A. J. Charlton, Lowden, Iowa.

BRAKE RIGGING FOR TRAILERS—Such as are drawn by motor vehicles, which brakes automatically upon a reduction of speed of the draft vehicle. Patent 1523853. M. W. Armstrong, Box 186, Placertia, Calif.

BRAKE-ADJUSTING MECHANISM — Whereby the adjustment may be accomplished at a point remote from the brake while the vehicle is in motion. Patent 1523903. L. M. Horowitz, 57 W. 73rd St., New York, N. Y.

CLUTCH AND BRAKE HOLDER FOR TRACTORS—So arranged and disposed that it may be thrown into locking position with the depression of a pedal. Patent 1523858. J. W. Buller, Hillsboro, Kansas.

News for Inventors

A Department of Facts and Notes of Interest to Patentees and to Owners of Patent and Trademark Rights

Conducted by Milton Wright

There are few better indices of the prosperity of the country and the condition of American industrial businesses than the news of patent developments. To provide authoritative news of such matters for our readers interested in business as well as a record of developments important to the inventor—professional or occasional—will be the purpose of this new department.

The Law Champions the Inventor

NEVER was the romance of American industry better exemplified than in the recent victory won by George Campbell Carson, poor inventor and miner against the American Smelting & Refining Company. The decision of the United States Court of Appeals in California is said to mean $5,000,000 in royalties directly from the American Smelting & Refining Company with probabilities of obtaining $15,000,000 more from other infringing corporations. An accounting is now under way.

Carson's patent, as the whole metallurgical world knows, provided "the method of protecting the walls of an open hearth or reverberatory furnace which consists in feeding the ores or fettling materials into the furnace chamber near the upper part thereof, and in causing the same to form a sloping embankment resting upon the floor of the furnace chamber and along the walls within the chamber between the bath and walls."

A remarkable thing about this patent with which Carson beat one of the strongest industrial organizations in the world in a fair fight is that the inventor acted as his own patent attorney and drafted his claims and specifications.

"Owing to that fact and his lack of skill and knowledge of patent office procedure his application met with many objections and delay. The first objection was that the claims covered two distinct and independent inventions. It was not until August 10, 1915 that the first patent was allowed and issued, with a single claim." He had filed the application for his first patent January 15, 1907.

When sued for infringement the American Smelting & Refining Company set up the defense that Carson's patent was anticipated by the Siemens' furnace, a British method. The Siemens' patent, however, was a failure and never went into use.

The court clearly defined the distinction between the effect of a foreign patent and that of an American patent saying:

"A foreign patent is to be measured as anticipatory not by what might have been made out of it, but by what is clearly and definitely expressed in it. An American patent is not anticipated by a prior foreign patent unless the latter exhibits the invention in such full, clear, and exact terms as to enable any person skilled in the art to practice it without the necessity of making experiments."

An Invention in the Sky

WITH only one year left to run, the patent for "sky writing" is held valid and infringed. The decision to this effect is handed down by Judge S. D. Bledsoe in the Federal District Court for Southern California in the case of the Sky Writing Corporation of America against Rogers Aircraft, Incorporated.

This sky writing patent was granted to James Means of Boston, May 25, 1909. One of the claims of the patent reads as follows:

"In an aerial machine a signaling system comprising in combination a vessel containing coloring matter, an outlet from said vessel, a valve for controlling said outlet and a transmitter for controlling said valve."

The appropriate appearance of the "smoke" was controlled by an ordinary hand lever in the defendant's device, yet the patentee used an electrical transmitter for this purpose.

The court reaches the conclusion that the invention of Means was a pioneer and basic one. While Means, the original inventor, did not fully appreciate and understand the scope and availability for use of his discovery and while he saw at the time only the possibilities of its use in war and not as an advertising medium, yet the law does not authorize another to infringe that patent which secures to the patentee the monopoly of any sort of sky writing from an aerial machine by means of the use of coloring matter, the output and deposit of which is controlled and determined by a valve.

Chief Justice Taft Makes A New Legal Point

SINCE 1880 it has been a well recognized principle of law, although the United States Supreme Court has never passed upon the point, that a man who assigns a patent right is prevented thereafter from attacking the utility, novelty or validity of the patent which he has assigned, as against anyone claiming the right or grant. As far as all the rest of the world is concerned, the patent may have no efficacy and may create no right of monopoly, but the assignor will not be allowed to question the right of his assignee or to exclude him from the patent's use.

Chief Justice Taft in a recent case of the Westinghouse Electric & Manufacturing Company against the Formica Insulation Company sets forth a new modification of this well established principle. It is this: where an invention and the patent rights to it are assigned before the patent issues, the assignor is allowed to attack the validity or scope of any claims in the patent which claims were made after his assignment took place.

The litigation involved a patent covering a process for making composite electric insulation materials using paper, muslin or other fibrous material. O'Conor, the inventor, was a mechanical engineer, employed by the Westinghouse Company with the understanding that any inventions he made were to be assigned to the company. He assigned his invention to the company, which, through its legal department, prepared his application for a patent. Later, while the patent was still pending, O'Conor left the company and went into business with two other men in the manufacture of electric insulating material. Four years later the patent was granted, additional claims having been made by the Westinghouse Company in the meantime. For three more years O'Conor's company continued to manufacture products described in his patent without objection by the Westinghouse Company.

Then the Westinghouse Company sued him for infringing his original patent. The case was fought through to the Supreme Court, where Chief Justice Taft writes the opinion settling the case once and for all in favor of O'Conor.

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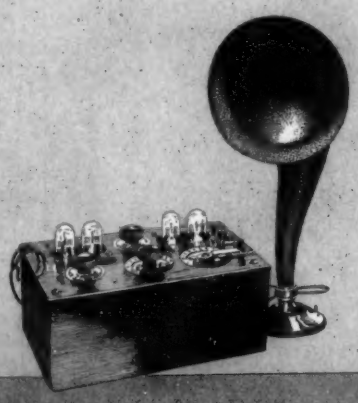

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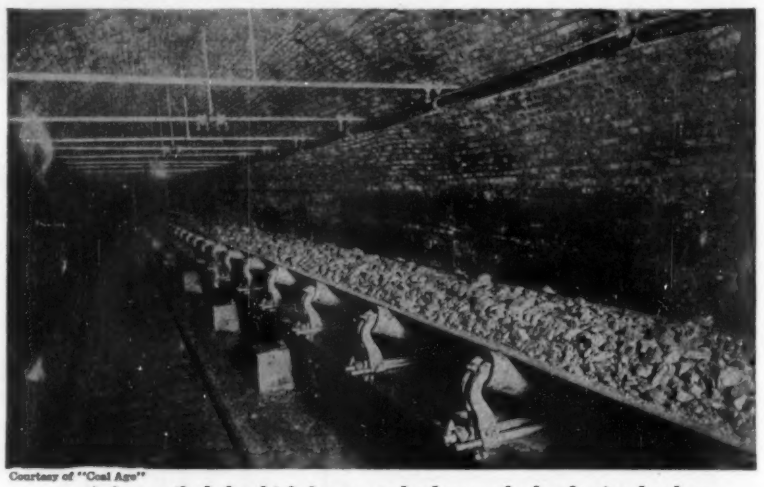
Conducted by Albert G. Ingalls

Belt-conveying System Replaces Mine Cars

A RECORD belt-conveyor system four and one-quarter miles long has been put into operation recently, for conveying coal from the adjacent mouths of three coal mines to barges in the Monongahela River, near Pittsburgh, Pennsylvania. This remarkably long belt carries coal at the rate of 1,500 tons per hour and takes the place of four thousand mine cars which would otherwise be required to do the same work. The belt was installed by the H. C. Frick Coke Company and it helps supply the coal for the immense by-product coking plant at Clairton, Pennsylvania. Conveying coal over such great distances in a steady stream instead of in separate cars is somewhat analogous to conveying oil across country in pipelines.



Courtesy of "Coal Age"

A four-mile belt which has ousted other methods of mine haulage

After thoroughly canvassing other means of conveying so large a volume of coal from the mine to the river, the company decided that none would be so satisfactory as a belt-conveyor, provided a system of such exceptional length could be made to operate properly. The distance was far too great to cover by means of one single length of belt and there was the problem, therefore, of making practical working connections between sections, of which there are twenty in all, ranging in individual length from 320 to 1,513 feet.

The belt is four feet wide for most of the distance and is made of eight-ply, thirty-two-ounce duck with a three-sixteenths-inch covering of rubber. The entire system required 47,000 linear feet of belt.

More than a million tons of coal have been carried riverward already, in a steady stream. The belts operate through a tunnel and are paralleled by a railway. The coal moves along at the rate of about six miles an hour, and since the individual lengths of belt must overlap like shingles, so that the coal may fall from the end of one to the beginning of the next, quite a little power is consumed in moving the system. The several belt sections run at a tension of from three to nine thousand pounds when loaded. The starting tension is about double the running tension, and a total power of two thousand horsepower is required to keep the coal moving.

The belt runs on three-pulley ball-bearing carriers all the way, and there are 39,588 places to keep lubricated. This in itself constitutes a considerable problem, but the lubrication is done by means of the Alemite pressure system and a periodical trip through the tunnel with a special lubrication car keeps the bearings properly greased. Flexible tubes can be applied to each bearing without stopping the belt.

The control is practically automatic, but several patrolmen are constantly on the move in the tunnel, looking for trouble. These men are in telephonic communication with the operator who can start or stop the entire system at once by simply pressing a button.

When the coal finally reaches the river after its long ride, it is emptied into a tipple for loading into barges. The bunkers of the tipple are suspended over the river and each holds 1,200 tons. Coal is run out through eight gates in the bottoms of the bunkers. These gates are spaced in such a manner that the coal feeds in uniformly separated streams into barges 175 feet in length. Thus each barge can be completely loaded without being moved during the process.

Only ten minutes suffices to load an 850-ton coal barge, and this amount of coal accumulates in the bunkers from the belt-conveyor in about half an hour. The system is now handling about twelve bargeloads of coal per day.—*Coal Age* (New York), vol. 26, pages 897-905 (December 25, 1924).

* * *

The Hybrid Steam Diesel Engine

BY fitting Diesel engine cylinders directly on top of the cylinders of marine steam engines two American marine engineers, William Griscom Coxe, Consulting Marine Engineer, of Philadelphia, and G. M. Lagergren, Chief Engineer for the Marine Department of the Pusey and Jones Company (Wilmington, Delaware), have provided an interesting solution to the problem of converting steamers to motor ships. Thus equipped, a ship may take advantage of the cheaper Diesel power without eliminating the possibility of reverting to steam power at any time should this become desirable.

Should the price of oil be so low as to make heavy-oil engine operation a profitable business, the new engine can run on its internal combustion side. On the other hand, should Diesel oil soar in price, as some anticipate will happen when many more motorships have been put into use, economical working can be still carried out with the unit running as a triple or quadruple expansion steam engine.

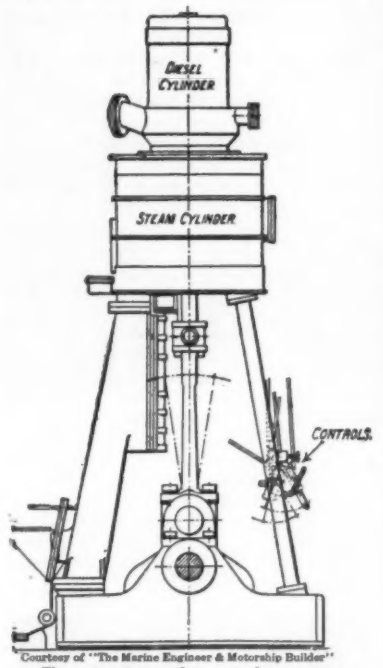
During normal times both steam and Diesel cylinders will operate in unison. It

is pointed out that since the new engine is definitely one for the conversion of existing ships from steam to Diesel engines, it should be received favorably in America where so much conversion of this nature is actually being done.

The inventors of this method claim that a saving in fuel expense of forty-five to fifty percent can be accomplished. In addition, the cost of the compromise conversion is less than twenty percent of the cost of a complete Diesel engine installation.

Details of a ship thus converted to the combination type of engine have been supplied by the designers. The original engine was a standard, marine, reciprocating, triple-expansion, steam engine having three cylinders of seventy-four-inch, forty-five-inch and twenty-seven-inch diameter, respectively, and a stroke of forty-eight inches. This engine develops 1,974 indicated horsepower at about seventy revolutions per minute, giving the vessel a speed of about eleven land miles per hour with a total daily coal consumption of thirty-four tons.

The main engine is being converted into a combined steam and internal-combustion engine of the new Coxe-Lagergren type, capable of developing 1,200 to 1,400 horsepower in the three superadded Diesel oil cylinders of twenty-five inch diameter each, augmented with enough power from the original steam engine to make the total power of the converted engine the same as before. This will permit the removal of one of the three steam boilers, thus providing more available cargo space in the steamer.



Courtesy of "The Marine Engineer & Motorship Builder"

Two engines that work as one

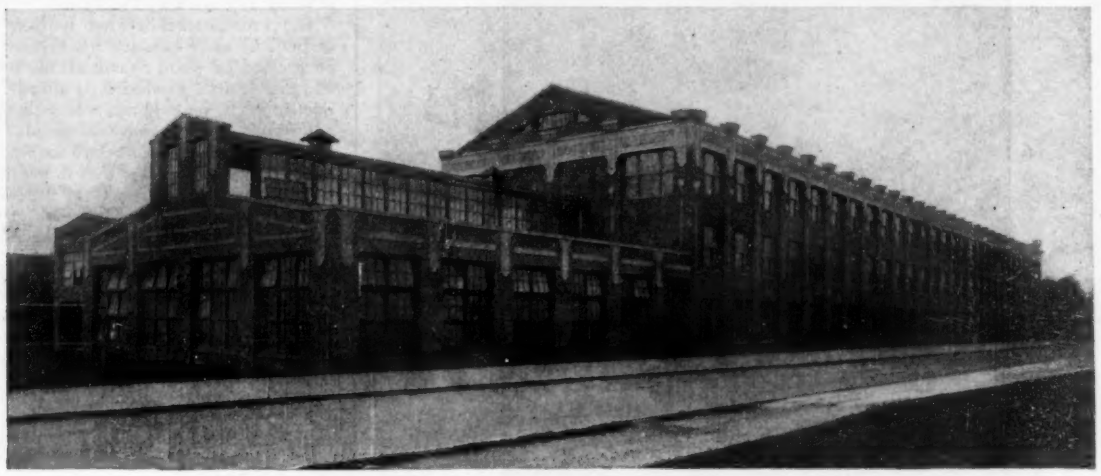
The Diesel part of the engine is of the semi-Diesel, two-stroke cycle type, with port scavenging and airless injection of fuel. It will burn the heavy grade of bunker oil which has a heat value of 18,000 British thermal units per pound. The steam entering the steam cylinders is made to pass around and into the skirt of the Diesel piston, thereby helping to cool the latter and at the same time superheating the steam, thus increasing the power output of the steam part of the engine. Since the pistons of the Diesel engine are directly connected with those of the steam engine beneath, the stroke of the Diesel engine is the same as that of the steam engine.—*The Marine Engineer and Motorship Builder* (London), vol. 48, pages 56-59 (February, 1925), see editorial, page 43, same issue.

* * *

When Shall the Saharan Camel Give Way to the Locomotive?

THAT the negro is ill adapted to the life of the great African desert is the statement of E. F. Gautier, of the University of Algiers, in Algeria. The negro perspires

➡Before you build a Factory or Warehouse~see Weyerhaeuser⬅



MODERN "MILL CONSTRUCTION" BUILDING—*W. E. S. Dyer, Architect and Engineer*

Sorting Out The Facts and Fallacies About Industrial Fire Safety

A message to Business Men about Weyerhaeuser-Ideal Industrial Construction

AS a result of twenty-five years of experience with so-called fire-proof industrial buildings, in comparison with the old standard "Mill Construction" factories and warehouses, some facts have come to light which may well be pondered by the industrial man who has a building program on his hands.

The only successful, sizable, concerted effort to reduce fires in American industry has been effected in buildings of the "Mill Construction" type.

* * *

As against fire risk from outside, between the "Mill Construction" building and the so-called fire-proof building there is little to choose. Both have fire-safe walls, roofs and doors—and presumably fire-guarded windows.

* * *

Nearly all fires start in the contents of a building.

* * *

For a sprinkler-protected "Mill Construction" building, the insurance costs on building and contents may be *lower* by 75% than in the case of a so-called fire-proof building without sprinkler protection.

In one section of this country there are hundreds of great "Mill Construction" factories protected by sprinkler systems against inside fires, on which the losses from fire over a recent 3-year period have averaged only 3½ cents per $100 of insurance written.

* * *

The "Mill Construction" building costs less to build—which means a saving in interest charges and a further saving in taxes.

* * *

Less money is tied up in factory and warehouse. More is kept liquid for working capital—to be converted into merchandise that can be turned over and over, showing a profit.

THIS is not meant to imply that all the new building should be turned back again to "Mill Construction."

Just when "Mill Construction" should be used is a question to be decided on its merits in each individual case.

It is the function of the Weyerhaeuser Expert Construction Engineer to advise on this matter—whether "Mill Construction" can logically be applied.

Weyerhaeuser was led to study this whole question of industrial construction as part of its program of enlightened lumber service to American industry.

The Douglas Fir mills of the Weyerhaeuser organization are producing selected timbers of the finest possible wood for "Mill Construction" needs.

Through the Weyerhaeuser distributing plants in the heart of Eastern and Mid-Western markets, these timbers are laid down quickly and economically in the principal industrial sections of this country.

Weyerhaeuser has put the results of its study into a book—"Industrial Buildings." This book is for the Business Man.

For his Building Engineer, Architect, and Purchasing Agent, there is another book, "Structural Timbers of Douglas Fir."

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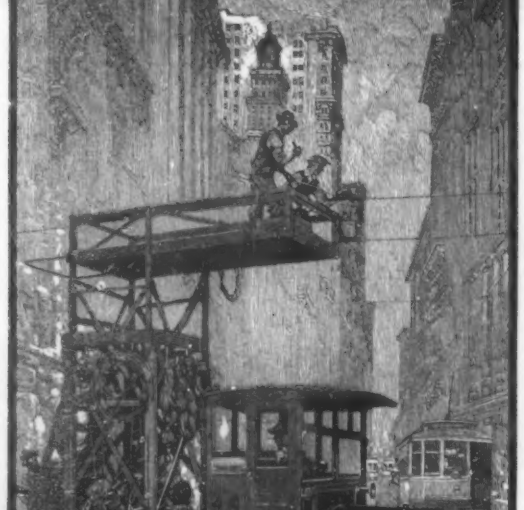

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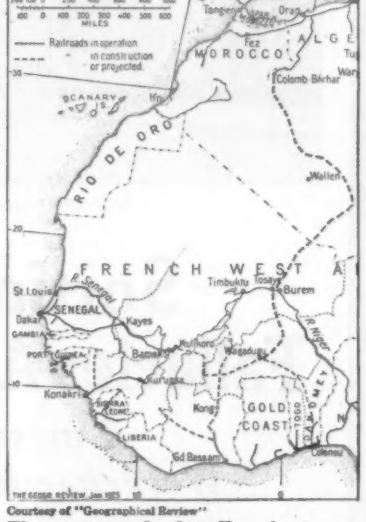
greatly and needs to drink much, a grave handicap in a country where the water must often be rationed. Moreover, he is a foot soldier and has to be taught to ride the camel. He will not be available for the long, slow physical conquest of the Sahara which is being attempted by the French.

The French trans-Saharan Railway must be built by white men and the country must be pacified by white Saharians, the Berbers and the Arabs. Pacified it is already, in a relative sense, yet only this winter the much-advertised trans-Saharan automobile tours had to be given up even before the first tour began, owing to the fact that it was impossible to guarantee the safety of the tourists. The natives of the desert are wild and turbulent. They are excellent fighting men.



Courtesy of "Geographical Review"

The route of the French trans-Saharan Railway, tapping the cotton resources of the fertile upper Niger Valley

In June of 1923, the Superior Counsel of National Defense, of the French Government, officially adopted the project of building a railway of standard gage across the Sahara, and entrusted the responsibility of construction to the Paris-Lyons-Mediterranean Railway, the most powerful of French railways.

Cotton has played perhaps the most important role in the French purpose to connect the region of the Niger River with the Algerian port of Oran by railway. In the valley of that river, above Timbuktu, there is a belt of land fifty miles broad and four hundred miles in length that because of its remarkable cotton producing possibilities has been described as a potential Egypt. This region is easily recognized on the map, being covered by a network of swamps and lakes. This is the flood zone of the upper Niger which is inundated annually by waters from the highlands. For cotton, the soil is right and the climate is right. France needs cotton.

Thus the trans-Saharan Railway project, the irrigation scheme for the Niger valley and cotton raising tie up together into a single story. No one imagines, however, that the construction of the railway line will take less than fifteen years after it has been begun. Even under the most favorable circumstances it will be twenty years before the first locomotive crosses the Sahara.—*The Geographical Review* (New York), vol. 15, pages 51-69 (Jan., 1925).

* * *

Atoms, Electrons and the Future on Earth

OF the several more or less popular and more or less lucid treatises on the atom and its constituents that have been written within the past three or four years we think Sir Oliver Lodge's new book, "Atoms and Rays" (George H. Doran, New York), is the best suited to the average reader of the Scientific American.

Taking for granted that practically everyone would at least like to understand the new science of the atom and the electron, the problem in recommending to the reader a suitable book on this subject is always a difficult one. It all depends on how much the reader already knows about science. Probably he is what book reviewers sometimes call "the average intelligent reader," an expression which pleases us all, but which after all does not tell us much, since we know that what one man would call a simple, elementary treatise, another would consider quite an abstruse treatise. Who, then, should essay to read and understand Sir Oliver's new book?

Suppose that one were a high school graduate and had taken a year of physics or chemistry, or both; suppose one were not, but had read quite a little about science in one's spare time; suppose that one had been a reader of the Scientific American—in any of these cases, "Atoms and Rays" would be comprehensible.

It ought to be stated, however, that no A B C book that could conceivably be written can possibly transmit to the reader an understanding of the elements of atomic science without study. Atomic science cannot be dished up all predigested. Nevertheless, Sir Oliver has the knack of getting down to the bottom of his subject and, seemingly, of anticipating the perplexities of the uninitiated reader.

It is the commonplace that most writers about technical subjects omit, thinking that, of course, the reader knows them already. Generally the reader does not. He wants the naïve approach to such a subject, though he does not want to be written down to. In short, he wants to know what it is all about, and particularly what, if anything, it *means*.

What, then, will the rapidly developing science of the atom do to the future of science and perhaps to our everyday lives? How different will your life and my life and our children's lives be fifty years from now if we find a way to use the wholly incomprehensible amount of energy that is still bound up within the atom?

In this country we have about twenty horsepower working for every inhabitant. Suppose some discovery should release for practical use the tremendous energy of the inner atom and provide each of us with, perhaps, ten thousand horsepower in place of twenty to direct and keep at work for us, what sort of a world would this become? Would life be better, worse, or merely different?

If one were to read ten pages of "Atoms and Rays" every evening for three weeks one would have gained a point of view on these matters. They are likely to become as significant to the generation which is growing up as the mechanical revolution brought about by the perfection of steam became to our fathers.

Courtesy of the Forest Products Laboratory

What we call wood rot is simply wood eaten up by fungi

A Close-up of Why Wood Rots

THERE is only one thing that causes wood to rot—fungi. Fungi are microscopic members of the vegetable kingdom and they do not like chemical wood preservatives. When wood has been soaked in these preservatives the fungi make no headway.

The Forest Products Laboratory, United States Forest Service, Madison, Wisconsin,

states that more than 1,500,000,000 cubic feet of lumber now standing in the forests will have to be cut down annually in order to make up for rot caused by wood-attacking fungi of various kinds.

If wood preservatives were used as much as they should be and if wood were stored and used to better advantage, this would not be necessary.

In the photomicrograph on page 332 showing some fibers of southern yellow pine greatly enlarged (heavy up-and-down lines), the thin, twisting, dark lines between the fibers are threads of a common wood destroying fungus. The white spots are punctures in the fiber walls made by these food-seeking fungus threads. By attacking the fiber walls, fungi weaken wood until it crumbles away in the last stage of rot.

* * *

Mapping Continents by Radio

DETERMINING longitudes by radio instead of by means of ordinary land telegraph apparatus is the recently developed method of the United States Coast and Geodetic Survey, described by Clarence H. Swick in a paper read before the recent Washington meeting of the American Astronomical Association.

For this work, which underlies the making of accurate surveys, radio has several important advantages over the telegraph, most of which could be summed up by the word, simplicity. What is wanted is a method of transmitting extremely accurate time signals from some central location to parties of precise surveyors working in the field. The objection to land telegraph wires is that they go only where they are put; while the putting is slow, often difficult and expensive. Radio waves, on the other hand, go practically everywhere that there is longitude and, in addition, to two places where there is none.

In determining these facts by means of radio the Coast and Geodetic Survey uses the same kind of astronomic transit that was used in determining them by means of telegraph wires. The radio receiving set may be practically any good, strong set which will receive the time signals sent out from the transmitting station at the Naval Observatory in Annapolis. This receiving set operates a sensitive relay, and the relay in turn controls a stronger electric current which operates a pen on the slowly turning drum of a chronograph.

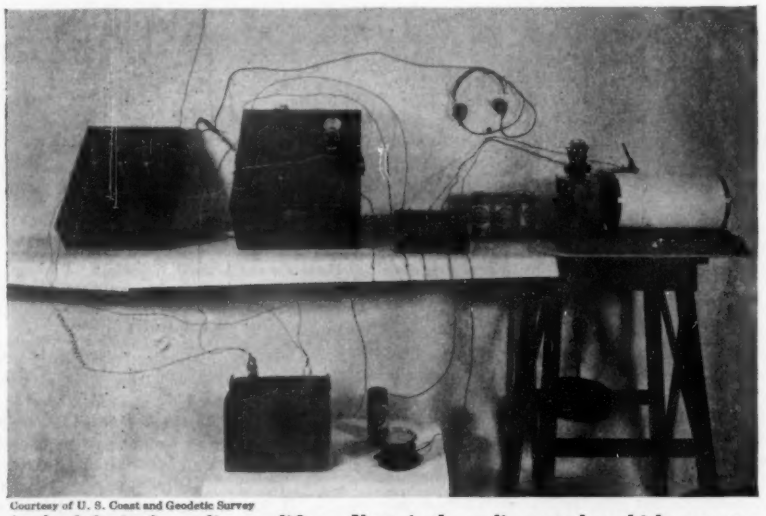
This chronograph is so arranged that the record of the transit, the time signal from Annapolis and the record of the ticks of a chronometer (see illustration) are all made by the same pen.

Another advantage of the radio method of determining the longitude of any point on the continent is that instead of two observing parties, one at the known station and one at the new station, only one party is now required. This saves money.

In Alaska, where seven radio longitude stations have been located by the Coast and Geodetic Survey, the running of wires to inaccessible points would have been not only very costly, but since most of these points are on hills or mountain peaks it would have been necessary to run telegraph wires to the closest convenient point and then to connect the latter points with the mountain-top stations by means of a subsidiary triangulation survey.

Since 1922, when the first radio longitude station was located at Wisconsin Rapids, Wisconsin, twenty-six stations have been determined by the Survey.

The time lag, owing to the extremely small yet appreciable time required to operate the various apparatus used, is about three one-hundredths of a second, even though it does operate automatically. In this length of time



Courtesy of U. S. Coast and Geodetic Survey

At the left, is the radio amplifier. Next, is the radio recorder which operates the pen of the drum chronograph (shown on the stand at the right end) and causes the pen to make a jog in the line traced on the revolving drum at each instant a time signal comes in. The chronometer, on the low table under the shelf, also operates the pen and causes a jog in the line for each second

Finding the exact longitude of a given point is something like a theorem in geometry. You have certain facts given, and certain others, to find. In determining the longitude of some place (your own present location, for instance) you would have given, an astronomic transit by means of which you could determine its local time by the exact instant when some chosen star crossed its tiny crosshairs and you would also have time signals sent to you either by telegraph wire or by radio.

What you have to find is, how many hours, minutes, seconds and fractions of seconds later the meridian on which you stand passed under this star as the earth rotates than the meridian of Greenwich or of Washington, or of any other accurately predetermined point of longitude, did. In other words, finding the longitude of any spot is only a matter of finding how long the earth took to turn from a place arbitrarily called the prime meridian to that spot.

the earth would turn about twelve feet, but since the time of lag is known it may be allowed for.

* * *

Is Mr. Bryan Ignorant of Evolution?

MR. BRYAN, the recognized leader of anti-evolutionary thought, is ignorant of the facts of evolution and has no legitimate claim to popular leadership in such an issue. This, in substance, was the statement made recently by Professor Edward L. Rice, of Ohio Wesleyan University, before the American Association for the Advancement of Science.

Although Mr. Bryan recently joined this great association himself, and it is hoped will now become letter-perfect in the scientist's point of view, (whether he accepts it is another question) an analysis of his writings against evolution shows that he has not taken the pains to inform himself even to the extent that could be done by reading an

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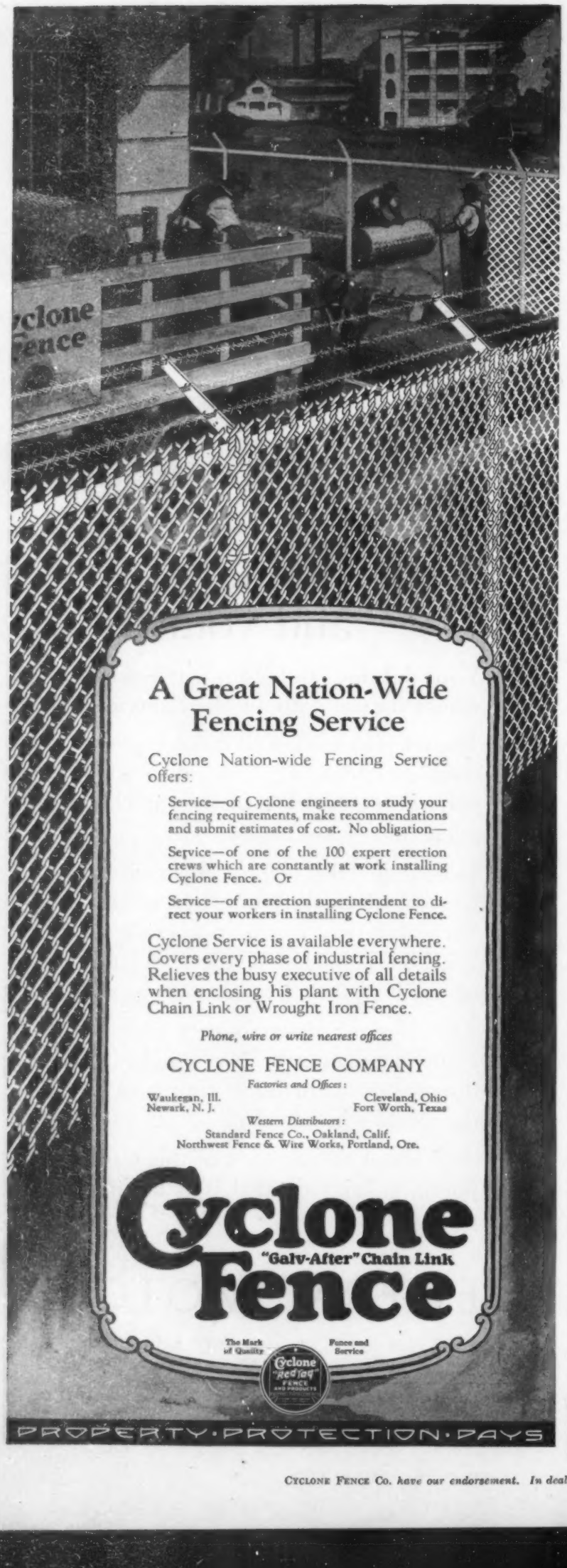
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elementary and general work such, for example, as Vernon Kellog's recent book entitled "Evolution." "Is there not," asks Professor Rice, "a moral obligation that a man professing authoritative leadership on evolution should first familiarize himself with the subject?"

There is not—or need not be—any quarrel between religion and science over evolution. Where quarrels have arisen they have resulted from a distortion of the respective sources, the Bible on the one hand, and the subject matter of evolution on the other. Mr. Bryan seems to confuse general evolution, which takes in about everything from the Universe down to the electron, with human evolution, which is only a small aspect of the whole subject, and with Darwinism, which is one interpretation of the cause of the evolution of biological organisms, including man.

Where Mr. Bryan dogmatizes, Darwin swings almost to the opposite extreme. It is a fact, however, that while many discuss the beliefs of Darwin, few take the time actually to read his original works and to find out just what he did believe. Instead of accepting evolution when he first outlined his hypothesis in 1837, Darwin spent twenty-one years examining and weighing the evidence. Then, in 1859, he published "The Origin of Species." If the anti evolutionary school of thought would actually *read* this book they would find in it more ammunition to fire against Darwinism than they have been able to derive from the Bible. That is because it was Darwin's inveterate habit to stand aside from his own work and deliberately to hunt out and include every possible bit of evidence that was contrary to his own conclusions. He had, in other words, the ideal scientific method—a true judicial passion for the truth no matter what the loss to his own prestige.

While Darwin himself was very mild concerning the aspects in which his work touched on religion, others who followed him partly distorted his statements. Haeckel, in particular, interpreted Darwinism to Germany and injected into it so many of his own modifications that Darwin reaped a harvest of bitter attack for beliefs which people credited to him, but which were quite unlike his own.

Professor Rice suggests that Mr. Bryan, when he writes of evolution, should get down to definite facts rather than opinions. He wishes Mr. Bryan would learn even so simple a matter as the famed seven categories of evidence in favor of evolution. These evidences are derived from embryology, homologous structures, geographical distribution, rudimentary organs, classification, modification under varying circumstances and geological succession. "Let us see," says Professor Rice, "how Mr. Bryan meets these various lines of evidence."

To the first three of these items, embryology, homologies, and geographical distribution, he finds no references in Mr. Bryan's writings. To the fourth category, the evidence of evolution from rudimentary organs, he makes in all his works merely a sarcastic reference to a young collegian, whose faith is shaken when his "attention is called to a point in the ear that is like a point in the ear of the ourang, to canine teeth, to muscles like those by which a horse moves his ears." Yet in man alone, and man is only one animal out of hundreds of thousands included in the scope of evolution, there are more than 150 recognized rudimentary organs.

Mr. Bryan does admit the fifth category, that of classification, which includes the similarity of structure between man and the apes, but he says, "the *whole* case (italics are ours) in favor of evolution is based on physical resemblances." Category six, modifications under varying conditions, Mr. Bryan simply denies. He says, "God's law, as stated in Genesis, is *reproduction according to kind*; evolution implies *not* according to kind."

Category seven, geological succession, is apparently intended as a categoric denial of the presence of connecting forms among the fossils, says Professor Rice; and continues, "Mr. Bryan can see no evidence for evolution in the marvelous wealth of fossil forms, some of them obviously intermediate in character between distinct species, genera or larger groups of today, and others forming unbroken gradational series between earlier and later fossil forms or between fossil and recent species."

In conclusion, Mr. Bryan advances no new evidence; the data collected by scientists he ignores or denies. In large part, doubtless, this difference is due to Mr. Bryan's "simple ignorance of the facts." He is sincere but not frank. His method is that of the lawyer striving to win his case rather than that of the earnest seeker for truth. The contrast with Darwin's method is striking.—*Science* (New York), vol. 61, pages 243-250 (March 6, 1925).

* * *

Do Animals Cross the Seas on Rafts?

KRAKATAO, the volcanic island which exploded in 1883 and destroyed all life on itself and a neighboring island, is once more becoming inhabited by several species of mammals, reptiles and wingless insects. We can understand how some of these animals found their way across the open waters of Sunda Straits to the little islands which were made wastes of ashes by the terrible explosion of Krakatao, but we do not know how the wingless insects and centipedes, for example, reached it.

When in August of 1883 the volcanic island of Krakatao exploded, shattering a cubic mile of rock into dust and sending out sound waves as far as Europe, these little islands were buried under hot ashes to a depth of 200 feet. For weeks the cover of embers glowed, and when it cooled down to ordinary temperatures not a living thing could be found.

Courtesy of "The Illustrated London News"

How do rats, land lizards and wingless insects such as spiders, and centipedes reach the island of Krakatao?

Since then, biologists have carefully watched the two islands, for it is of great importance that science should know how animals manage to reach new lands across the seas; whether by swimming, on floating driftwood, on floating islands or otherwise. Twenty to thirty miles away across the Straits of Sunda that sunder the Island of Sumatra from the Island of Java there was a rich flora and a rich fauna.

Vegetation was the first to come and stay, for animal life depends upon vegetable life and if any animals did come before the vegetation arrived it is certain that they perished of starvation. Flying animals came next. In 1908, twenty-five years after the disaster, the python and a lizard had come; but these are good swimmers and no terrestrial animals had yet arrived. But by 1921 rats had reached the island and spread all over it, while there were two kinds of geckos—little land lizards—as well as eleven species of wingless insects, four species of centipedes and seventy-three species of spiders. The spiders—at least some of them—were probably drifted out on strands of gossamer. The others may have crossed by means of driftwood.

All these facts were discovered through the work of Dr. Dammerman, of the Buitzenzorg Museum, (Buitzenzorg, Java) who for years has been watching the rehabitation of Krakatao and Verlaten after their animal and vegetable life were obliterated by the great volcanic explosion of 1883.—*The Illustrated London News* (London), vol. 166, page 262 (Feb. 14, 1925).

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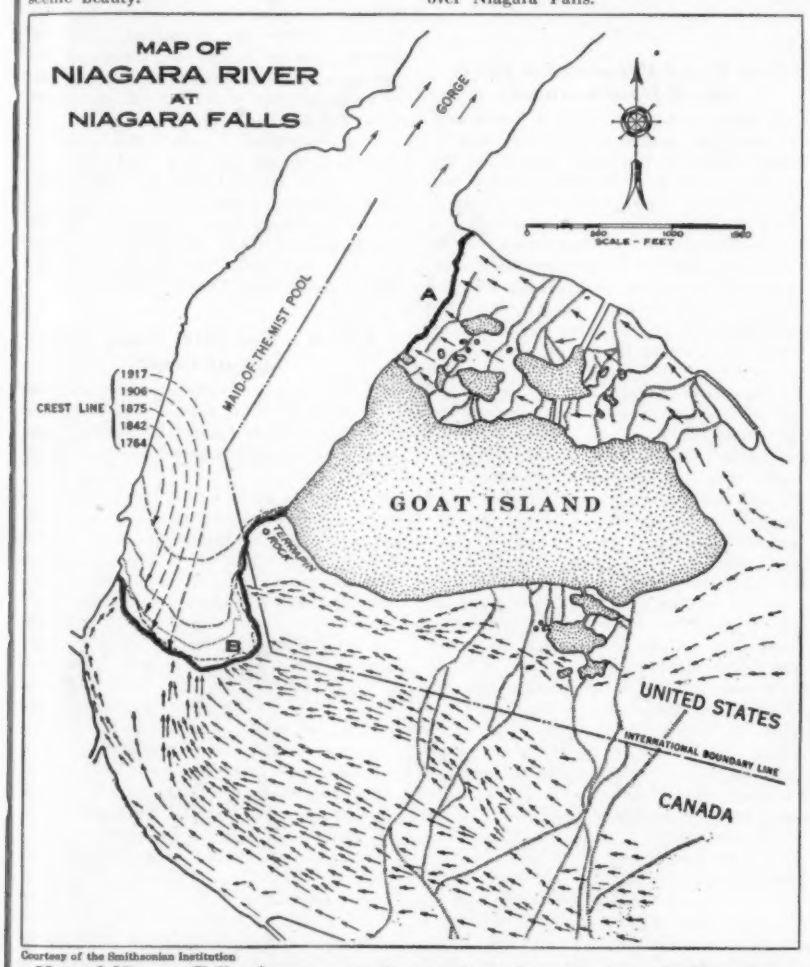
Niagara Falls are Committing Suicide

THAT the Canadian part of Niagara Falls is committing suicide is the statement made by the Smithsonian Institution of Washington, D. C., in a booklet entitled "Niagara Falls: Its Power Possibilities and Preservation." Between 1875 and 1906 the Canadian Falls cut their way upstream into the rock over which they fall at the very slow rate of only two inches per year, but since 1906 this rate has increased thirty fold, the Falls now receding at the rate of five feet per year. The only way to prevent this rapid recession will be to construct islands or a submerged dyke above the Canadian Falls so as to prevent the concentration of the water in the V-shaped notch through which by far the largest part of the water is now flowing. This would secure a fairly uniform distribution over the entire crestline.

The report of the Smithsonian Institution, written by Samuel S. Wyer, Associate in Mineral Technology of the United States National Museum, covers briefly but clearly five separate aspects of Niagara Falls. These are, its engineering description; the economical aspects of its electric power development; Ontario and United States electric service compared; the diversion of water from Niagara Falls; and the preservation of their scenic beauty.



Courtesy of the Smithsonian Institution

Map of Niagara Falls, the arrows indicating how the water is gradually swinging into a narrow channel and ruining the scenic beauty of the Falls

Niagara Falls is the dividing line between two radically different methods of rendering electric service to the public; governmentally owned on the Ontario side, privately owned but governmentally regulated on the United States side. Why the Ontario domestic consumers of electricity get lower priced electric service than the domestic consumers in the United States is explained as a case of doubtful economics, votes controlling the situation but the public footing the bill in the last analysis.

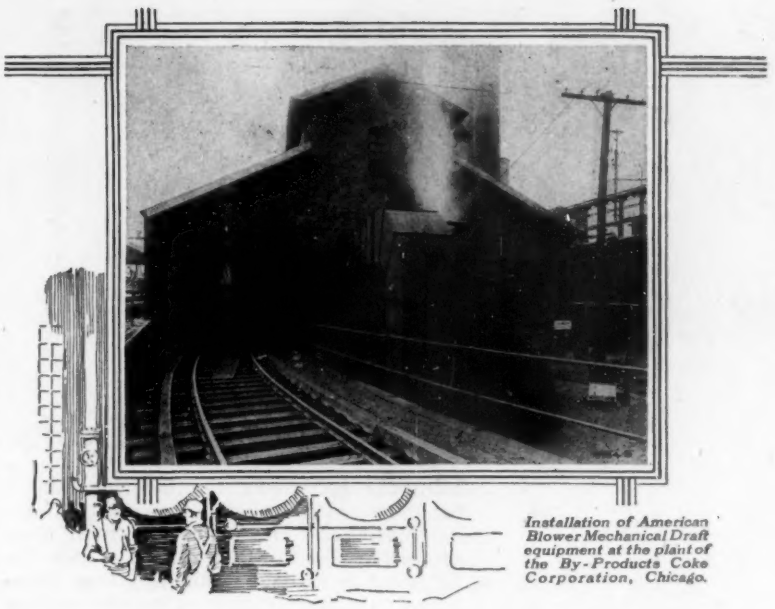
Recently many of the engineering publications have contained discussions, sometimes acrimonious, of the fight over the diversion by the city of Chicago of a large volume of water for the purpose of carrying off that city's sewage into the Mississippi River system. This water just about equals in volume the total amount of water going over the American Falls at Niagara Falls. Practically all of the cities, states and provinces bordering on the Great Lakes have strongly opposed the city of Chicago. Recently the Supreme Court of the United States rendered a decision that Chicago must cease to divert more than 4,167 cubic feet of water per second from the Great Lakes. At present, however, 10,000 cubic feet are being diverted.

The Smithsonian Institution states that Chicago is unnecessarily wasteful of its domestic water supply, owing probably to the fact that the domestic water consumers of that city get their water at a flat rate without meters. This always results in waste. For illustration, Chicago uses 175 percent more water per capita than Cleveland.

Chicago still has a water diversion problem, says the Smithsonian Institution, because instead of using modern sewage treatment and disposal methods it is still following the medieval method of dumping its raw untreated sewage into the Chicago River. In order to protect its water supply from Lake Michigan from pollution by its own sewage the city is diverting water from Lake Michigan to flush the sewage into the Mississippi River system. And the water diverted at Chicago cannot, of course, flow over Niagara Falls.

About 88,000 cubic feet of water per second, says the report, could still be harnessed at Niagara Falls for power development without loss of scenic effect. This water would develop 2,500,000 additional horsepower. About 67,000 cubic feet are already being diverted, of which 8,000 cubic feet are diverted at Chicago, and 3,200 feet near Niagara Falls for canal navigation in the Welland and the New York State Barge Canals. For power purposes alone 56,000 cubic feet are being used, as authorized by the present treaty with Canada.

All waterfalls slowly recede upstream. This is because the hard stratum of rock over which the water drops is gradually eroded away by water friction, by the scouring of grit in suspension in the water and



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We are also using 4 American Blower fans for handling hot gases from our coke ovens. This enables us to generate 1000 boiler horse power for every pair of fans.

The American Blower equipment was chosen because we were convinced that it would give good service. It has been very satisfactory and we have experienced no mechanical troubles. Under similar conditions we would repeat our orders.

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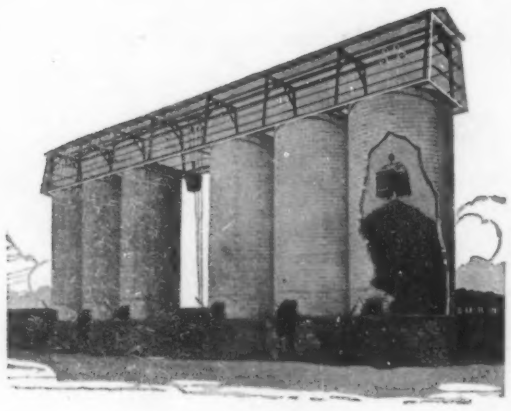

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by the action of frost on the rock. Since the Glacial Epoch, Niagara Falls has receded about seven miles. As the Falls flow over the hard Niagara Limestone, and since this stratum dips slightly towards the south, as the Falls recede their height slowly diminishes, thus within a few thousand years, if nothing were done to prevent it, Niagara Falls would practically disappear and the level of the Great Lakes would be greatly lowered.

The recent and striking increase in the rate of recession of the Canadian side of the Falls is due to the shape into which the crestline of these Falls has now worn itself. What was once a beautiful horseshoe shaped crestline is now becoming ragged and V-shaped, and since the Canadian side carrying ninety-four percent of the water naturally tends to cut back faster than the American Falls, and since this enormous flow is largely concentrated in a deep V-shaped notch, this very concentration increases the rate of recession still more.

If no water were diverted from the river, it would in no way retard the suicidal tendency of the Canadian Falls, says the Smithsonian Institution, but on the contrary, on account of the larger volume of water that would then be concentrated in the notch, there would be an actual increase in the rate of recession. Non-use would not be preservation.

* * *

New Wood Preservative Introduced from Germany

WOLMAN salts is the name of a new kind of wood preservative which has recently been introduced into this country for the preservation of wood wherever wood is subject to decay. This preservative is used in about the same manner as creosote, but it is odorless, clean, leaves no stains, can be painted or varnished and costs only about one-fourth as much as creosote. It also renders wood extremely fire-resistant. The new material is already being used by several American railroads for tie preservation and for preserving the timber of which wooden freight cars are made. It is also being used for the impregnation of mine timbers and telephone poles.

Although new in this country, Wolman salts were first used in Germany nearly twenty years ago. By the time they had become well established, a time when their use in other lands should logically have begun, the World War intervened. Thus Germany already has an experience of some twenty years in their use. There, railroad ties impregnated with Wolman salts have been in the ground more than ten years and may be examined today. Such an examination made recently of several thousand such Wolmanized ties indicate that ten more years of service may still be expected of them. In Germany, it is said, many people keep in their dooryards a sunken barrel of Wolman salts solution into which all kinds of poles and posts which are to lie in the earth are soaked

Wolman salts consist essentially of sodium fluoride and cresols. They are deadly to the many kinds of fungus that cause wood to rot. They are soluble in water, while creosotes are soluble only in oil. This is important because the cells of wood fiber naturally take up and conduct water, but tend to repel oils. Thus it is possible to treat wood with Wolman salts in about one-fourth the time necessary for similar treatment with creosote. Yet so harmless are the salts to the wood itself that treated wood may be made up into furniture of good appearance.

Wolman salts, which are manufactured by the American Wood Impregnating Co., (New York) have found a rather unique application in the cotton spinning industry. Spinning mills must always maintain an atmosphere nearly saturated with moisture. Otherwise the cotton spins poorly. Under such circumstances, any other kind of roof than wood drips; and this, of course causes trouble. The wooden roofs of the cotton mills soon decay, however, and require constant replacement. But owing to their inoffensive nature Wolman salts are now being used for the impregnation of the roofing lumber for many cotton mills in the south and in New England.

* * *

In Railway Tunnels the Engine Crew Chokes More Than You Do

WHEN you are annoyed by the fumes that penetrate the passenger car in which you are riding through a long railway tunnel as black as ink, what kind of a time are the members of the engine crew having? They cannot dodge some of the smoke as you can, by closing the windows.

Several series of experiments have recently been made both by the Bureau of Mines (Washington, D. C.) and by individuals, with a view to finding out just what causes the discomfort experienced by the engineers and firemen of locomotives.

It was found that the increase in temperature in the engine cab, sometimes to 158 degrees, Fahrenheit, is not due to the hot stack gases, but to the humidity caused by steam carried in them.

Experiments were made in an effort to improve this condition.

Cool air was taken from the rear part of the locomotive at a level of two feet above the tracks and forced into the cab by means of electric, motor-driven blowers, but this did not relieve the discomfort. This air became quickly heated by reason of the proximity of the boiler, and if there was any effect at all, the discomfort of the engine crew was increased.

This discomfort, it was found, could be decreased by the use of a smoke deflector such as the Union Pacific Railroad places on its engines, causing the exhaust gases to stream backward over and away from the engine cab.—*Railway and Locomotive Engineering* (New York), vol. 37, pages 264-268; also editorial, page 276, September, 1924.

* * *

Can We Get $100 From One Ton of Coal?

WHAT is the low-temperature carbonization of coal? What does it produce? Is it a success? Should one take stock in companies which paint a glowing picture of its future?

In order to explain what the low-temperature carbonization of coal is we must first explain what the high-temperature carbonization process is. The high-temperature carbonization of coal is simply the regular, everyday process of the city gas works. Coal is put into retorts which are heated from outside. Since the retorts are closed the heated coal can get no oxygen. Therefore it cannot burn. When it is heated to above 1,400 degrees, Fahrenheit, illuminating gas is driven off and coke as well as tar remains.

Suppose that instead of heating the coal to above 1,400 degrees we were to heat it to somewhat below that temperature—perhaps 1,100 degrees, Fahrenheit. The products that result will not now be the same as those named above. Instead of getting gas and coke we will get gas, and large amounts of a fuel resembling coke; also a liquid gasoline substitute, lubricating oils, and ammonium sulphate. This is the low-temperature carbonization of coal, and its importance is slowly growing.

Today there are about twenty different patented low-temperature carbonization processes, each of which produces a slightly different group of products. Some of these processes are fairly successful on a small scale, particularly the two small plants operated by the Ford Motor Company at River Rouge, Michigan and at Walkerville, Ontario.

The majority of the low-temperature carbonization processes have been developed in England. There many of the controlling conditions are very different from those here. This is important. England uses smoky soft coal for house heating. Therefore, the smokeless fuel produced by low-temperature carbonization should find a comparatively wide market there. Here, at least in the east, it would have to compete with anthracite coal.

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Research has been done on the low-temperature carbonization of coal by the United States Bureau of Mines (Washington, D. C.) and by the Carnegie Institute of Technology (Pittsburgh, Pa.). Articles concerning the processes have appeared in *Mechanical Engineering* (New York) and particularly in the New York technical publication, *Combustion*, during 1924. Two books, each entitled "Low Temperature Carbonization," appeared in England last year. One is by Wellington and Cooper (C. Griffin and Co., London); the other is by Lander and McKay (Ernest Benn, Ltd., London, publisher).

"Coal Carbonization" (The Chemical Catalog Co., New York, publisher), a new book by Horace G. Porter, a Philadelphia chemical engineer, includes a twenty-page discussion of the various processes of low-temperature carbonization now under development. Summarizing these processes the author says, "These processes are, none of them, as yet proven in a commercial sense, that is, so as to show their ability to carbonize coal at costs well within the revenue to be derived from the products." Like other critics of the low-temperature carbonization of coal, Mr. Porter apparently advises us to proceed; but to proceed with caution.

The technical difficulties involved in the successful solution of the low-temperature processes have not yet been fully solved. One difficulty is heating the whole mass of the coal hot enough without getting the outside of the mass too hot. Keeping the coal stirred up is another difficulty. These things can probably be overcome. Can we say as much of the marketing difficulty? Can our home-owners be educated to prefer the extremely light, porous fuel like coke which the low-temperature carbonization produces to anthracite?

The yields given by the various processes of low-temperature carbonization are not all alike, either in quantity or in nature, although they all produce gas and they all produce light coke. The by-products have a variable range depending on a large number of conditions. The amount of gasolene substitute obtainable is frequently exaggerated, not more than four gallons per ton of coal usually being secured. The low-temperature carbonization of coal produces but one-third as much illuminating gas per ton as the high-temperature process, although the low-temperature process gas has half again as much heating value as that of the older process.

The coke-like fuel is unquestionably smokeless and gives more heat than the coke we have now. But much of that so far produced has been too breakable, light and bulky, and it burns up too fast. This can doubtless be remedied and the fuel should then sell at twice the present price of coke.

To sum up, there are fairly good prospects for the new method of treating coal, but its development will probably be gradual. Some say there is one hundred dollars worth of salvageable material in each ton of soft coal. Can we capture these dollars?

* * *

When Is a Man Drunk?

"WHEN he has been drinking, no matter if only one drink," say some. "When he can no longer move a muscle," say others. This vexed question is largely a matter of one's point of view, the law having failed to define exactly what drunkenness is.

The law does not draw, in fact, any clear distinction between the two ridiculously extreme points of view mentioned above. Whether a man is drunk or not in the eye of the law depends more or less on where he is, what he is doing and to what extent his intoxication might menace others.

Thus a man who is engaged in driving a locomotive—or a motor car—may be regarded as drunk when his brain and muscle co-ordination have been but slightly affected by intoxicants. Another man, let us say some Robinson Crusoe, could become very deeply intoxicated without injuring his neighbor, his family or society in general, although he might injure himself.

Sir James Purves-Stewart, Senior Physician to Westminster Hospital, London, in addressing the Society for the Study of Inebriety in January of this year attempted to define the various degrees of intoxication and to give tests for drunkenness. Not every man that shows the common signs of intoxication has been drinking alcoholic beverages, he says. There are people who act as if intoxicated when they are greatly excited. Others suffer from nervous diseases which display symptoms resembling those of drunkenness. It is necessary for police officers to know how to distinguish such cases, unless the victims are to be treated unjustly.

Smelling a man's breath is not a sure test for drunkenness. He may have some nervous disorder of the kind just mentioned, and coincidentally he may have taken only a single drink a short time before. This in itself would not render him drunk. Even anatomical deformity may cause a man to simulate the drunkard's wobbly gait.

The smell of alcohol is conclusive evidence that the patient has recently swallowed alcohol, but nothing more, says Sir James. Even this, however, is no longer a watertight criterion, for a man in New Jersey recently lost his automobile driving license because his daily work as a chemist required him to inhale alcohol fumes all day, and these actually did intoxicate him. When the man was first arrested the newspapers merely stated that he was intoxicated, which, in fact, was exact. Apology was rendered him the following day for the injury that might have been done to his reputation, but his license could, of course, not be restored, because, regardless of the cause of his intoxication, he was a menace as a driver.

A later stage of alcoholic poisoning is that of stupor. The individual is unconscious, the pupils are dilated, the skin warm and moist, the temperature below normal. Even here, warns Sir James, we must be cautious in our diagnosis, for a patient with an attack of cerebral hemorrhage may have had alcohol given him afterwards.

A friend of the reviewer—a man who never drank alcohol at all—while riding a bicycle fell, became partly unconscious and was approached by someone who, in attempting to administer whisky, poured it liberally over the victim's person. When the ambulance arrived this man's breath was found to smell strongly of alcohol. Still unconscious, he was placed in the alcoholic ward of a hospital. Here was a case where the breath test was worthless.

"To my mind," says Sir James, "the presence of alcohol in the cerebro-spinal fluid is really the only sign at our disposal. If positive, it is conclusive evidence of alcoholic poisoning." But this test, requiring the puncture of the spinal canal is not feasible in the common run of police court cases suspected of alcoholic intoxication. There is, therefore, no short cut to the accurate diagnosis of drunkenness, a fact which should be remembered by the censorians.—*The Lancet* (London), vol. 208, pages 52, 90, 111, 115 (Jan. 17, 1925).

* * *

Smooth Sand Cuts as Well as Sharp Sand

SAND of the kind that is used with powerful currents of compressed air for cleaning the walls of brick or stone buildings does not have to have sharp or angular grains. Grains that are rounded cut nearly as well and they last altogether longer because the grains do not break up so easily. The sand that is used in sand blasting is used over and over again, and while most of us associate sand blasting with the renovation of the outside walls of city buildings, more sand is used in a similar manner in foundries for smoothing castings than for the former purpose. It is also used for carving and engraving on stone and marble, for glass cutting, and for preparing the surface of metals for the electrolytic bath as well as for putting the final finish on metal surfaces of various kinds.

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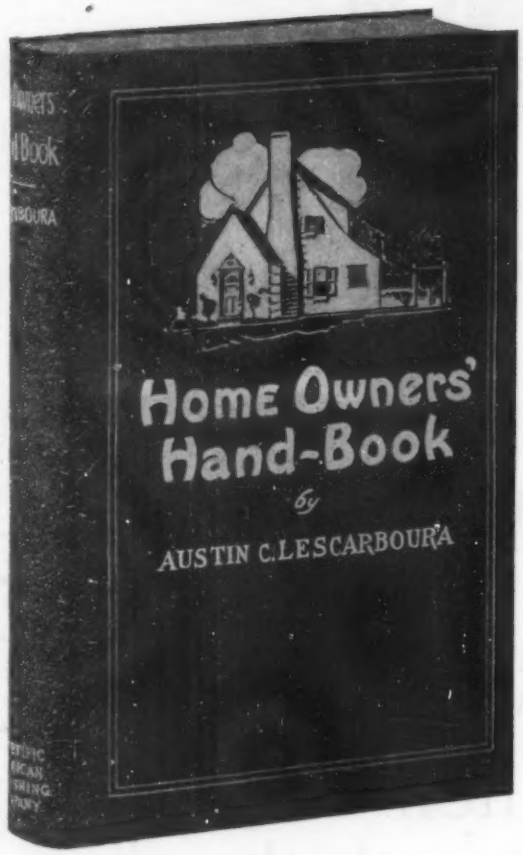

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oxide. This is because it is much harder. One consumer of sand blasting sand reported that he used a certain sand because it had angular grains which made it cut better than the round grains. But an examination of the grains under the microscope showed that they were decidedly rounded.—*Rock Products* (Chicago), vol. 28, pages 31-32 (Feb. 7, 1925).

* * *

Wing Motion of Various Insects and Birds

AN insect is so light that it has little momentum, so that the wings must continually pull the body forward as well as lift it. Since there is little momentum the lifting and the pulling must be as nearly continuous as possible. Therefore, the wing motion of insects is comparatively more rapid than that of birds. The common cabbage butterfly moves its wings at the rate of 540 strokes per minute; the sphingid moths at the rate of 4,320 beats per minute; the wasp at the rate of 6,600 beats per minute; the honey bee at the rate of 11,400 beats per minute; while the wings of the common housefly vibrate at the rate of 19,800 beats per minute.

The difference in the area of the wings of a mosquito and of a stork, relative to the widely different weights of their respective bodies, may be appreciated when it is realized that if a stork had wings proportionately as large as those of a mosquito the wings would have an area of almost twenty-eight and a half square yards, and an expanse of more than twenty-five feet.

Of all the insects the large dragon-flies, so common about the ponds and streams in which they live when young, are the swiftest on the wing. One sort of these (*Austrophlebia*) was timed by Dr. R. J. Tillyard, who found that it covered between eighty and ninety yards in three seconds, which means that it was flying at the rate of nearly sixty miles an hour.

Dr. Alexander Wetmore has recently determined that the great blue heron flies at the rate of twenty-eight miles an hour, the red-tailed hawk at twenty-two, the flicker at twenty-five, and the raven at twenty-four. Thus, it is evident that the large dragon-flies have little to fear from birds, though many of the smaller, weaker ones are eaten by them. Birds that travel at a rate approaching that of the large dragon-flies often become victims of their own speed. Being heavy, they cannot turn aside to avoid danger. Put a net suddenly in front of them and into it they go.—*Scientific Monthly*, Jan., 1925, page 18.

* * *

Trees That Are Almanacs

TREES that give weather reports for ages long past when there was no other weather bureau to record them, are described by Professor A. E. Douglass of the University of Arizona, in the annual report of the Smithsonian Institution (Washington, D. C.).

Professor Douglass's studies are based on minute examination of the annual growth rings of trees. He begins with the commonly known fact that these rings are formed at the rate of one a year. The light, porous section grows in the spring when there is plenty of water, and the denser part grows when the summer drought comes. This investigator has studied the effect of years of drought as compared with years of plenty. Every event in the life of a tree left its record in the rings.

After discovery the correlation between known historical climatical conditions and comparatively recent tree rings, Professor Douglass began to carry his researches back into earlier centuries, using trees of the age-old forests of the southwest as his time-sticks. Weather records of the time of the discovery of America, of the time of the Crusades, of the days of the Norman invasion of England, and of even more remote periods, can be read on many stumps.

One of the interesting pieces of information shared by the trees is a confirmation of the theory of an eleven-year sunspot cycle held by astronomers and weather students. Every eleven years there is a band of relatively narrow rings, indicating a time of heat and drought, with wider rings in between that tell of easier times.

* * *

Tinkering with the Universe

THE element hydrogen is unique; its atom appears to consist of a single proton as nucleus, with only one planetary electron. Hydrogen is the only atom in which the nucleus is not composed of a number of closely packed protons. Theory indicates that when such close packing takes place the effective mass will be reduced, so that when four protons are packed together with two electrons to form the helium nucleus, this will have a weight rather less than four times that of the hydrogen nucleus.

This is actually the case. It has long been known that the chemical atomic weight of hydrogen was greater than one quarter of that of helium, but so long as fractional weights were general there was no particular need to explain this fact, nor could any definite conclusions be drawn from it. The results obtained by means of the mass spectrograph remove all doubt on this point, and no matter whether the explanation is to be ascribed to packing or not, we may consider it absolutely certain that if hydrogen is transformed into helium a certain quantity of mass must be annihilated in the process.

The theory of relativity indicates that mass and energy are interchangeable and that in centimeter-gram-seconds units a mass m, at rest, may be expressed as a quantity of energy mc^2, where c is the velocity of light. Even in the case of the smallest mass this energy is enormous. If instead of considering single atoms we deal with matter in quantities such as we meet with them in our ordinary experience, the figures for the energy become prodigious.

Take the case of one gram-atom of hydrogen, that is to say, the quantity of hydrogen in nine cubic centimeters of water. If this is entirely transformed into helium the energy liberated will be $0.0077 \times 9 \times 10^{20} = 6.93 \times 10^{18}$ ergs. Expressed in terms of heat this is 1.66×10^{11} calories; or in terms of work, 200,000 kilowatt hours. The transmutation of the hydrogen from one pint of water would liberate sufficient energy to drive the Mauretania across the Atlantic and back at full speed.

Should the research worker of the future discover some means of releasing this energy in a form which could be employed, the human race would have at its command powers beyond the dreams of scientific fiction. But the remote possibility must always be considered that the energy once liberated will be completely uncontrollable and by its intense violence will detonate all neighboring substances. In this event all of the hydrogen on earth might be transformed into energy at once. The success of this costly experiment would then be published at large to the universe simply as the sudden appearance of a new star.—*Scientific Monthly*, February, 1925, pages 137-138.

* * *

A Billion Other Galaxies

THOUSAND of universes, each similar to the lens-shaped galaxy of stars of which our sun is an insignificant member, with the nearest universe so distant that before it reaches us its light travels for a million years at a speed which would circle the earth seven times in a single second, have been shown to exist by Dr. Edwin P. Hubble, of the Mt. Wilson Observatory, according to a report of the meeting of the American Association for the Advancement of Science, held in December, 1924.

Through telescopes these universes appear to be clouds of light, more or less circular, and with a spiral structure. By means of variable stars in these distant galaxies—stars that undergo a peculiar periodic variation in light, the distance of a few of them has been determined, and, in the opinion of Dr. Harlow Shapley, director of the Harvard College Observatory, this proves the theory that they are "island universes" lying entirely outside of our own system.

The "Margery Mediumship"

By William McDougall

Professor of Psychology in Harvard University

The following statement by Dr. McDougall, member of the Scientific American's Psychic Committee, was printed in the *Boston Evening Transcript* for February 18, 1925, and is reprinted here by courtesy of the editor of that newspaper. Formal statements by the members of the Psychic Committee (including Dr. McDougall) regarding the Margery case were printed in the Scientific American for April, 1925. Dr. McDougall's article, given below, is in amplification of his previous statement and outlines some of the evidence on which the claim of Margery to the Scientific American's prize was rejected by the Committee.

DURING the past year the "Margery mediumship" has excited a considerable amount of interest in the Boston area; and owing largely to the activities of Mr. Houdini, Mr. Malcolm Bird and Sir A. Conan Doyle, the fame of the case has been carried far beyond the frontiers of New England. I understand that Mr. Bird will shortly publish a book devoted to the description of this strange case; and if one may judge from a brief report in the transcript of an address recently made at Chicago by Mr. Bird, it would seem probable that his book will imply a very favorable verdict on it. Mr. E. G. Dingwall, the expert investigator of the English Society for Psychical Research, recently devoted the chief part of a lecture before a large and select audience at Jordan Hall to the description of phenomena presented by "Margery"; and the honor of presiding over that meeting fell to me.

Further, as a member of the committee invited by the Scientific American to judge the claims of "mediums" to produce supernormal physical phenomena, I have devoted a considerable amount of time to this case during the past sixteen months. For some months, I have been the only member of that committee permitted to take part in sittings with the "medium." Thus a considerable responsibility toward the public rested upon me, or so it seemed to me; and I hoped to reach a very clear-cut opinion upon the case, before making any statement about it. With that end in view, I had hoped to have a few more sittings during the present month. But the state of affairs I have indicated forced my hand and led me to write last week a letter to the editor of the Scientific American stating an opinion adverse to the claims of the "medium," together with a statement (signed by Dr. W. F. Prince, one of my fellow committee-men, and myself) to the effect that in our opinion the prize offered by that magazine should not be awarded to Margery, she having failed, in spite of ample opportunities, to convince us of the supernormal character of any of her phenomena. The latter statement, together with a part of my individual statement and a somewhat inaccurate account of the then state of affairs, was published in the *Boston Herald* and the *New York Times* of February 12.

In view of the circumstances related above, I feel it necessary to supplement the two statements mentioned and therefore, write the present article with two purposes: First, to say a few words in vindication of the Scientific American's committee. Secondly, to explain my own position in the matter and to justify, as far as it may be done in a few sentences, my adverse verdict of "not proven."

The Conditions of the Investigation

The members of the Scientific American committee, or most of them, have labored without reward in the tedious and trying tasks of investigation, believing that, in so doing, they were rendering a public service of some slight importance. They have been covered with abuse from many quarters. Mr. Dingwall, in a most gratuitous and unjustifiable attack upon them, has described their work with "Margery" as a vaudeville show. Dr. Morton Prince has rushed in to pronounce their work a fiasco (see *Boston Herald*, February 8). Dr. Crandon described them as dishonest mountebanks. Mr. Bird says that we have "refused to risk" our "scientific reputations" by giving a favorable verdict. From Sir A. Conan Doyle and from other quarters come denouncements of the committee on the ground that it has not defended "Margery" against the outspoken criticisms of one of its members, Mr. Houdini. In regard to the last charge, I will only point out that, in respect of the principal accusation made by and against Mr. Houdini, the other members of the committee, if they were to take sides in the matter, would have to accept the word of one party against the other, and that they have no sufficient ground for preferring the word of the "medium" to that of their colleague, Mr. Houdini.

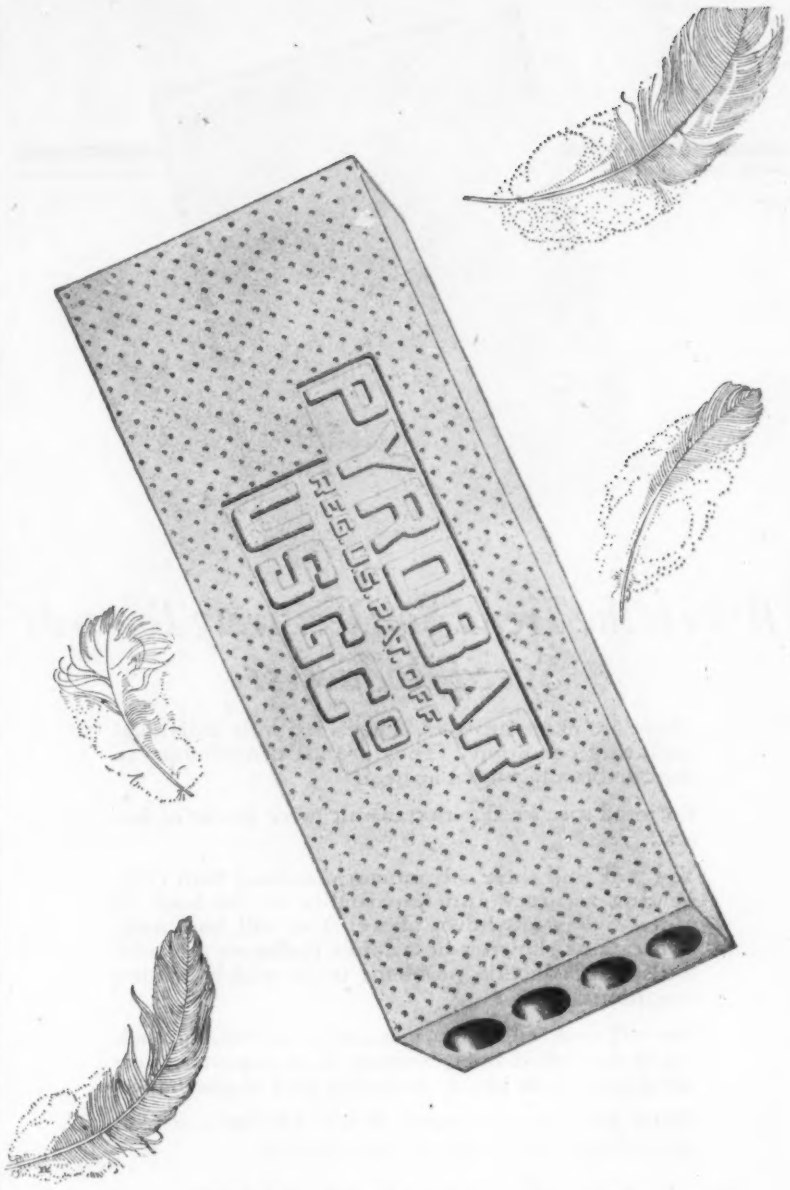
I will not dwell upon the extreme difficulties of this particular investigation, difficulties much greater than in the case of a professional medium or one for whom the money-prize is a strong attraction. I will point out only that in such a case all the cards in the game are stacked in favor of the "medium," especially in that the investigator works under the perpetual veiled threat of exclusion from further sittings, if he should break in the slightest degree the rules laid down by the "medium" or the "control," or is otherwise indiscreetly critical.

Twenty Sittings Since September

In spite of these difficulties, vastly increased by the unfortunate degree of publicity given to the case by Mr. Bird's articles about it in the Scientific American (articles for which the committee had no responsibility and which unfortunately it was powerless to control or inhibit) and by Mr. Houdini's many public statements about it, those members of the committee who have been permitted to have sittings with "Margery" since the Houdini explosion of last August have continued to work upon it and have been able to reach a verdict and then discharge their task. It should be noted that the committee was not asked, and did not undertake, to explain how alleged supernormal phenomena were produced; it undertook only to say, in the case of each "medium" competing for the prize, whether the medium had or had not, after being given ample opportunity, succeeded in convincing them of the supernormal character of some one or more of the phenomena presented.

In September of last year on my return to Cambridge, I intimated that I was prepared to take part in three or four sittings a week until such time as I might be able to reach a conclusion, truthfully alleging that my mind was open to a favorable view of the phenomena. Since that date I have been allowed to take part in about a score of sittings. All of these were held in the "medium's" home; for I have tried in vain to secure a few sittings in the Harvard laboratory. I have throughout followed the policy of conforming strictly to the conditions demanded by the "control," believing that in this way I should best conduce to the occurrence of phenomena, and that, if only phenomena would occur, I should by close observation be able to arrive at an opinion about them. In spite of this docile attitude on my part, some of the score of sittings were blanks and in others of them phenomena were very scanty.

Nevertheless, I have been able to arrive at an opinion which I am prepared to defend against all the many believers in the supernormal character of "Margery's" phe-



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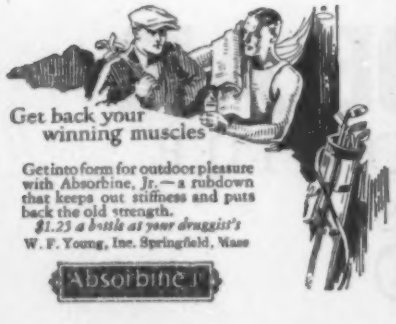
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nomena, or to modify radically if good cause can be shown. That opinion is that very many of the phenomena have been produced by normal means and that in all probability the same is true of all of them. As I have pointed out elsewhere, it is, in the nature of the case, impossible to prove a negative, to prove that 'Margery' never did, never can, or never will produce any supernormal phenomena. A verdict is necessarily given in terms of probability. Some things have happened the means of production of which I am unable to describe. But, as these have happened under conditions very unfavorable to accurate observation, to attach great weight to them would imply undue credulity. The reader will notice that I do not assert (and the committee does not assert, as has been incorrectly stated in the press) that "Margery has failed to produce any evidence of supernormal phenomena." She has produced a very considerable quantity of such evidence. The defect is in respect of the quality rather than of the quantity of the evidence. What I do assert (and with this I think most of the members of the committee would agree) is that the evidence of the opposite tendency far outweighs the evidence of supernormality.

Let us try to indicate very summarily the nature of this large mass of adverse evidence, premising that a fair-sized volume would be required for any complete statement of it. First, some of the more striking phenomena have been produced in such a way that one is compelled to assert that, if they are supernormally produced by the "control," Walter, then it follows that Walter goes out of his way to deprive them of all evidential value and simulate their production by normal means. I give one example, the production of a paraffin glove claimed to have been molded on an "ectoplasmic" hand formed during a sitting, in the fashion alleged by Drs. Richet and Geley to have occurred in another case.

The "Mysterious" Paraffin Glove

The occurrence was as follows: In the midst of a sitting at which we had been led to expect the occurrence, upon the table in the midst of the circle, of a phenomenon of a very different type, Walter called for the bucket of paraffin which had been prepared some days previously; it was warmed and placed close to the medium. After we had waited in darkness for some little time Walter directed one of the sitters to search for the promised paraffin glove in a corner of the dimly lighted room. On following Walter's directions, the glove was found, cold and solid, wrapped in a piece of dark cloth, at a distance of some ten feet from the "medium." As the room had not been searched before the sitting, it is obvious that this find was devoid of evidential value; whereas, if Walter had adopted the simple and straightforward course of laying the glove upon the table, instead of in a remote corner of the room (in a dark cloth), the evidential value of the phenomenon would have been very great. Further, in spite of the astonishing success claimed for this first attempt, no further endeavor in this direction has been undertaken, I believe; a fact which it would be proper, if it were not invidious, to connect with the further fact that it was openly proposed by some of the sitters to add to the paraffin during the darkness of the next experiment in this line the contents of a packet of coloring matter, chosen at random from several such packets of various colors.

Secondly, there has been, throughout the whole period of my observations, a most disturbing inconsistency in the phenomena. For example, Walter claims to have produced a perfectly formed ectoplasmic hand at the first attempt, in the instance cited above. Yet many months later when, under the persuasive guidance of Mr. Dingwall, he again produced an "ectoplasmic hand" on several occasions, the "hand" presented on each of these occasions only a very rough and remote resemblance to a human hand. Or again, Walter professes to have freely and repeatedly moved a table, a stool, and a heavy screen, sometimes at distances of many feet from the medium and sometimes in fair red light. Yet in ringing the bell-box, which required only a minimal pressure applied to any part of a large surface exposed in the immediate neighborhood of the medium, Walter seems to have found the utmost difficulty, except when operating in complete darkness.

The More Care, the Less Wonder

Thirdly, in general it is true to say that, the better the conditions of control, the scantier and slighter have been the phenomena produced. Thus the "ectoplasmic hand" exhibited abundant and most intriguing movements upon the table, so long as the "medium's" right hand was controlled only by her husband and by one of Mr. Dingwall's luminous bands sewn upon the cuff of the loose sleeve enclosing her otherwise bare arm. But, as soon as adequate control of both hands was established, no such movements occurred. Further, the levitation of the megaphone above the medium's head has been reported again and again in darkness and in red light during loose mixed sittings. But, although I have asked frequently for its repetition under good conditions of control nothing of the sort has occurred within my observation. Yet again, the whispered voice has been reported by various observers to have come from all sorts of places and directions remote from the medium, yet in all my long and careful attempts to verify this, I have never been able to observe any indications that the voice came from any other source than the "medium's" mouth, and on the contrary I have observed many indications that it does come from that source.

Fourthly, I emphasize the general evasiveness of the "control"; the avoidance of crucial conditions; the leading off with promises of wonderful new phenomena; the perpetual insistence upon the continued accompaniment of a gramophone and of conversation, which grossly interfere with accurate observation, etc., etc.

What Clinched the Decision

In a recent letter to the press, Dr. Crandon complains that I seem to have made unduly rapid progress towards my adverse verdict in the last few weeks. Perhaps in the letter from which he cites I stated my openness of mind towards the phenomena too strongly. Such self-estimates are a delicate matter, and still greater is the difficulty of expressing them accurately. However that may be, three things have happened to clinch my opinion since the writing of that letter. First, the letter in question was written to invite Dr. Crandon to a very frank conference, in the course of which I laid before him all my grounds for refusing to give a favorable verdict (with the exception of one very strong piece of specific adverse evidence) and urged him to cooperate to the utmost in attempting to secure some one clear-cut supernormal phenomenon, however simple, under good conditions of control. The large prize offered was that in case of success, Mr. Dingwall would be able, in his lecture at Jordan Hall, to make a statement favorable to the mediumship. The only result of this conference was that in the course of the ensuing week I was given a single sitting, my last, in which, for the first time during the Dingwall series I was allowed continuously to control the "medium's" right hand, while Mr. Dingwall controlled her left hand —and nothing happened, the sitting was completely blank.

Secondly, on the Friday afternoon before Mr. Dingwall's lecture, I had, for the first time, an opportunity to examine the series of photographs of "Margery's ectoplasm" (taken by Dr. Conant with magnesium flashlight). Some of these had been taken during sittings in which I took part; but the more interesting were taken at private sittings given to Mr. Dingwall at which I was not allowed to be present. But since Mr. Dingwall showed all these photos on the screen at his lecture, I can hardly be

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expected to abstain from all reference to them. On the afternoon mentioned, examining the photos with a lens, I was able to point out to Mr. Dingwall that some of the photos of 'ectoplasm' presented all the appearances of the lung of some animal surgically manipulated to resemble roughly in shape a human hand.

Thirdly, I have not been able to obtain the gift or the loan of any copies of these photos for the purpose of submitting them to the judgment of experts.

I have no doubt that Dr. Crandon, if he will carefully examine the photos with a good lens, will recognize the appearances I refer to. I hereby invite Dr. Crandon to submit the complete series of photos (especially the one showing the 'ectoplasm' lying across Mr. Dingwall's hand) to three independent experts, one of whom shall be the professor of physiology in the Harvard Medical School, and a second the director of the Zoological laboratory of Harvard University. If two of the experts do not endorse the judgment of my inexpert eye, I will retract the foregoing statement concerning the ectoplasm. If they should confirm it, Dr. Crandon will, no doubt, argue that, when Walter molds the ectoplasm into any particular form, he necessarily or naturally gives it the texture of one kind of animal tissue or another, and that, in producing an 'ectoplasmic' formation that resembles both a hand and a lung, he has furnished the best possible proof of the supernormal origin of the formation. This reasoning could not be refuted. But it remains probable that men of science, being notoriously hard-hearted and sceptical of marvels, will prefer to believe that the lung-like tissue took shape in some more usual fashion. Especially will they be difficult to persuade that Walter, in moulding the mass to the semblance of a hand, would choose to use a knife upon it.

Why Such Vague Statements?

One more word upon the mystifying 'ectoplasm.' It is reported in the press that in a recent lecture Mr. Bird took exception to the verdict rendered by the committee, approved "Margery's ectoplasm," and said that the 'ectoplasm' "issues from openings in the anatomy." The last statement is correct. There is good evidence that 'ectoplasm' does issue, or did issue on some and probably on all, occasions from one particular "opening in the anatomy." The more interesting question is—How did it come to be within "the anatomy"? There was nothing to show that its position there and its extrusion from that place were achieved by other than normal means.

I have reason to believe that some of those who attended Mr. Dingwall's lecture feel that some apology or explanation is due to them for my appearance as presiding officer on that occasion, at a time when my opinion was already very adverse to the phenomena. I humbly submit the following. Mr. Dingwall, a fellow-countryman and an officer of the English Society for Psychical Research (of whose council I have been a member for many years) was a stranger in Boston. When, therefore, a few days after his arrival, he told me that he had consented to address the Boston members of the American S. P. R., and asked me to preside at the gathering (as I have usually done at other meetings of the group) it would have been churlish to refuse. When, some days later, I found that Mr. Dingwall was inclined to take a very favorable view of "Margery's" phenomena, and that her friends were expecting the lecture to take the form of a complete vindication of her mediumship, and when, to my dismay, I found that invitations had been sent out rashly announcing a lecture on the "Margery" case, I took steps to put before Mr. Dingwall my grounds for maintaining a most rigid reserve as to the supernormality of the phenomena, pointing out to him that even his own sittings afforded abundance of such grounds. He thereupon agreed to speak of the phenomena in an entirely non-committal shape. The lecture was given in that form. I hope that no harm was done beyond still further forcing me towards a premature announcement of my opinion.

As Dr. Worcester was named at Mr. Dingwall's lecture as a cooperator in these investigations, I wish to say that Dr. Worcester, throughout these trying circumstances, has cooperated in a wholly admirable manner, showing nothing but a sincere desire to ascertain the truth.

May Be the Case of Dual Personality

In conclusion I would say that I am prepared to consider the hypothesis that "Margery" is an extreme case of double personality, and that the secondary personality, going by the name of Walter, has been the prime mover and agent in the production of all the phenomena of this remarkable case.

If that hypothesis is the correct one, then the case is one that falls within the field of abnormal psychology rather than in that of supernormal physical phenomena.

Science Notes

The Spread of the Destructive Gypsy Moth

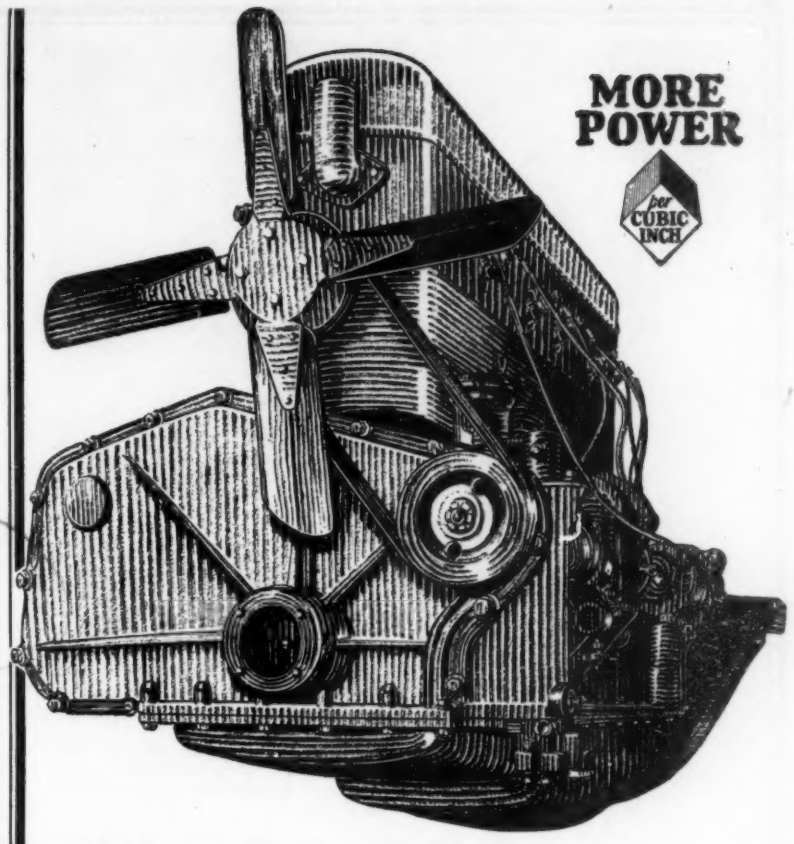
THE gipsy moth has proved such a destructive insect in New England and New York that the New York State Conservation Commission, in cooperation with the federal government, has established a barrier zone in an attempt to stop the westward spread of the pest. In spite of the fact that this moth is a winged insect, it does not occupy new territory through its power of flight. On account of the extreme weight of their bodies the females are unable to fly.

The spread of the moth occurs when the young caterpillars are first hatched from the eggs. The caterpillars have long hairs growing out of their bodies. These hairs, it is thought, together with the silk which the caterpillars spin, help to buoy them up in the wind which sometimes carries them from a half mile to five miles from their starting place.

Last year, in order to learn about the winds which caused this gradual spread of the caterpillar aeronauts, 7,000 hydrogen-filled toy balloons were sent up by the commission. Each balloon bore a numbered tag requesting the finder to return it with a record of the time and place where it was found. Over 400 of these tags were thus recovered by the end of the season. They were found practically throughout southern New England, a number being picked up on both the eastern and southern coasts. One balloon was found off Yarmouth Cape, Nova Scotia, proving a drift of about 400 miles in eighteen hours. Seven covered distances of 110 to 145 miles. One drifted 65 miles at the rate of 100 miles an hour. Another remained in the air six and a quarter hours and then dropped at the point of release, evidently carried back by a counter current.

Jellying Power of Glues and Gelatines

IN the *Journal of Industrial and Engineering Chemistry* C. R. Smith describes a method for determining the jellying powers of glues and gelatines by the use of the polariscope. It would appear that the gelatines of the highest jelly strength approximate a definite maximum value measured between 35 and 15 degrees, Centigrade. A reduction in the rotation parallels a decrease in the jellying power. Tables are included in the article, giving the rotations of gelatines and glues at the temperatures mentioned and also data on the rotation and jellying power of various samples, including hide and sinew samples. It is stated that a progressive increase in levorotation obtained from a solution cooled quickly below 35 degrees, Centigrade, and accompanied by the production of a jelly after a change of approximately 4.7 degrees is very positive proof of the presence of gelatine in any solution concentrating enough jelly.



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Learning to Use Our Wings

Aircraft are being put to use in peace as well as in war. This department will keep our readers informed of the latest facts about airships and airplanes

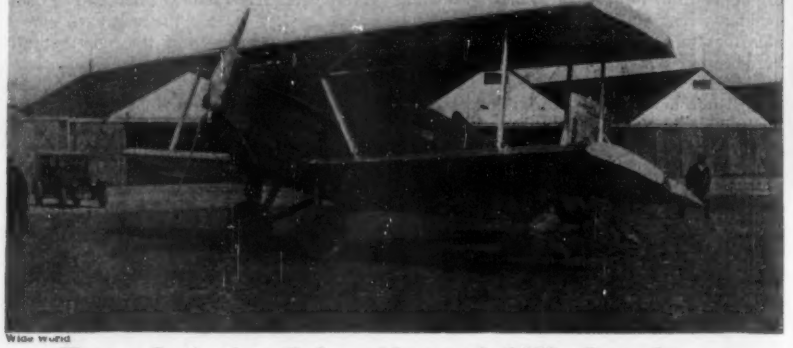
Conducted by Alexander Klemin
Associate Professor of Aeronautics, New York University

New Mail Planes

WHEN the Air Mail Service first started operation, the Army had great numbers of De Havilland observation planes on hand. These planes gave the Post Office an abundance of cheap material. The De Havillands, reinforced and changed by the operators, gave yeomen service, but it is a question whether the gift of war machines really meant economy. The planes of antiquated type required much careful overhauling and, in spite of their powerful Liberty motors, were only capable of carrying 500 pounds of mail. Now the Air Mail has placed an order with five different manufacturers (Curtiss, Huff-Daland, Elias, Boeing and Douglas) for one experimental type of Liberty motor plane which is expected to give greater security and economy of operation.

"ceiling" of 15,000 feet so that they can climb rapidly out of a field or above the clouds when necessary.

Planes built by the above companies, in accordance with these general requirements, will be tested at the Air Mail field nearest to each manufacturer. Our photographs show the first of the planes to be tested, the Curtiss Company's Carrier Pigeon. This plane showed itself capable of an initial climb of 1,000 feet a minute and a high speed of 120 miles per hour. The tremendous depth of its fuselage is explainable by the fact that letters and mail are bulky for their weight, and the cubical contents of the metal-lined mail compartment must be large accordingly. Above all, mail must not be destroyed by fire. Therefore, in the Curtiss plane the huge gas tank, sufficient to give a cruising radius of over 400 miles, is placed

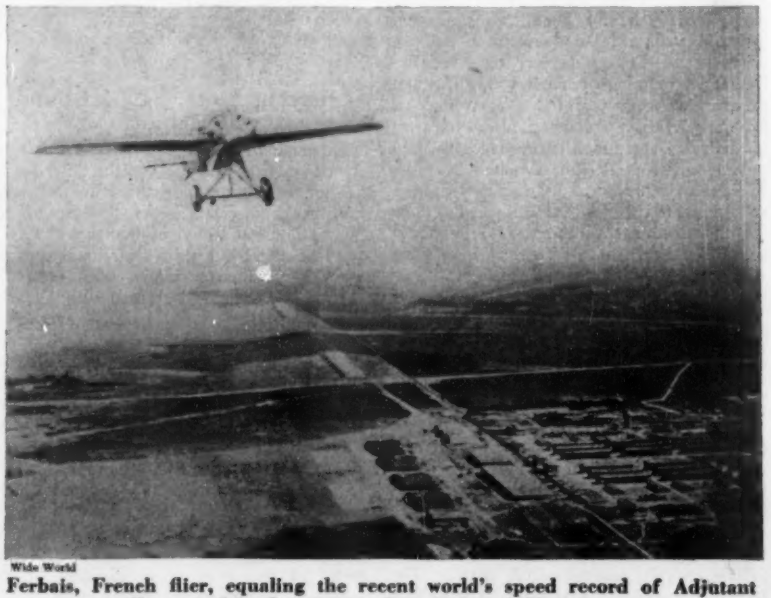

Wide World

The new Curtiss air mail plane with a speed of 120 miles an hour

The present cost per ton-mile of air mail is $2.63. The new planes must carry 1,000 pounds, so that the cost of operation per ton-mile may be nearly halved, with twice the old "pay load" in each ship. In the course of the year, night service will be extended to the New York-Chicago leg of the transcontinental route where emergency fields are not so frequent or convenient as they are in the western prairies. Accordingly, the new planes must land fully loaded at less than fifty miles per hour, whereas the De Havillands land at close to sixty miles. They must cruise comfortably at one hundred miles an hour; and have a

in the bottom of the fuselage in such fashion that it can be detached and dropped in the air at an instant's notice. It is partly for this reason that the landing gear is so definitely split into two parts, offering no hindrance to the fall of the tank; partly because with a landing gear of this type an obstruction between the landing wheels is not likely to make the plane nose over on the ground.

The Air Mail superintendents and mechanics like to have the fewest possible number of spare parts. This reasonable desire has been taken carefully into account by the Curtiss Company's designers. Thus,


Wide World

Ferbais, French flier, equaling the recent world's speed record of Adjutant Bonnet while flying over the aviation field at Istres

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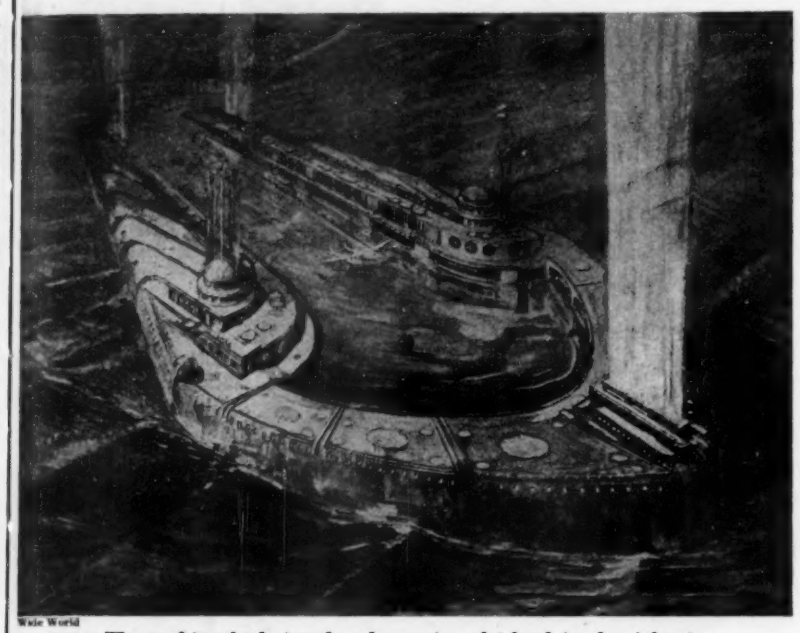
the upper wing-spread is shorter than the lower wing-spread by exactly the width of the fuselage. Hence, the right or left halves of upper and lower wing are exactly interchangeable. In similar fashion, the two ailerons, the elevators and the rudder are so proportioned as to be alike in every particular.

Such details do not constitute progress in aerodynamics but they will do a great deal to cheapen original construction and subsequent maintenance of planes. Perhaps other manufacturers will disclose similar commercial features which the Air Mail is so wisely encouraging.

Mid-ocean Airports

WHEN seaplanes are considered for transoceanic traffic, it is found that they cannot carry enough fuel for a crossing and have any reasonable amount of "pay load" left over. This objection does not apply to airships, but the suggestion has often been made that mid-ocean airports could be established where seaplanes could alight in perfect safety and refuel. It has remained for a countryman of Jules Verne to embody the idea in a series of imaginative plans. M. Defrasse, a French architect, has won a prize in the Salon of French Artists for his drawings and descriptions.



Wide World

The architect's design for the projected island in the Atlantic

The *New York Times* speaks of a huge floating island built of reinforced concrete, shaped like a horseshoe, 1,400 feet in length and 700 feet in width, with an interior basin. This basin would permit seaplanes to alight in its sheltered enclosure. The closed bow of the island would be headed constantly into the wind by means of propellers, the open end would have barriers to keep out the waves and the heavy seas. Ballast and heavy drag chains would serve to provide equilibrium and anchorage. Gigantic lighthouses, repair shops and hangars would complete the equipment.

The artist certainly shows a plausible conception in the photograph we reproduce. The cost is estimated at only $20,000,000 for one of these islands.

Mountain Flying

A NUMBER of German resorts are famous for their winter sports. There being no snow in Bavaria this winter, a contest for airplane pilots to climb the Zugspitze (Germany's highest peak, 9,720 feet high) was improvised instead. Our photograph shows the winning pilot, Botsch, with his twelve horsepower "baby plane."

In scoring points time was not the only element taken into consideration; engine power, fuel consumption, the weight of the machine and its dimensions were all taken into consideration.

Atlantic-Photo Company

The winner of the contest and his twelve horsepower baby plane

It is interesting to see how close to the ground the pilot is seated. There is practically no exposed landing gear such as we are accustomed to see in an ordinary large airplane, the wheel axle apparently going right into the fuselage. The internally braced monoplane wing fits smoothly on top of the fuselage. This is also an important factor in diminishing resistance.

The Magnus Effect in Aviation

THE Scientific American has recently described Flettner's famous rotor ship and set forth the principle on which it is based.

An advertisement for the Consulting Service Division of the Smith Gas Engineering Co.

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The converting of hot producer gas plants to clean cold producer gas plants and extending the utility of producer gas to many refined heating operations where accurate control of processes is necessary.

The creation of methods of utilizing cheap gas of low heating value as efficiently as gas of high heating value.

The developing of apparatus for the efficient production of fuel gas from low grade lignite, wood refuse, sawdust, shavings, etc.

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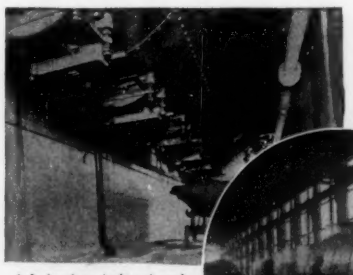
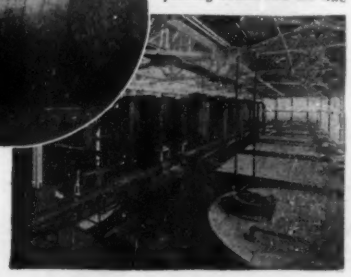
Trench digging machines for public service pipe lines
Garbage disposal and rendering plants for municipalities, packing houses and the like



Ash bunker designed and manufactured by the Manufacturing Division of the Smith Gas Engineering Co.

Riveting and welding seams on tanks, work done by the Manufacturing Division.



Chemical storage tanks at the Iron Mountain Plant of the Ford Motor Co. The Manufacturing Division has fabricated 73 tanks for this concern.

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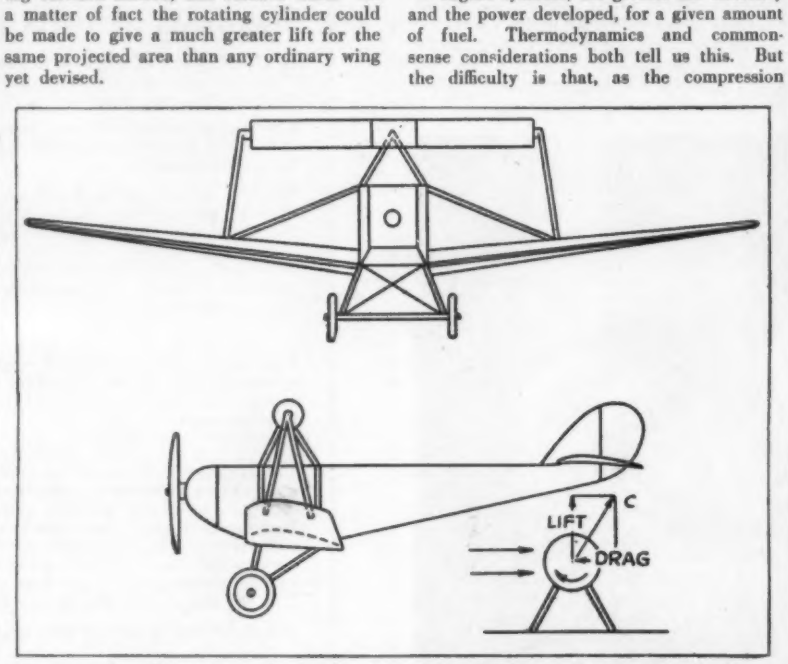
Readers will recall that this involves a force at right angles to the wind, when this wind strikes a rotating cylinder. Can this "Magnus Effect" be applied to aviation? Theoretically, yes.

There is no reason at all why a rotating cylinder should not be substituted for the ordinary wing, with the usual engine and propeller overcoming resistance and providing forward motion, and relative wind. As a matter of fact the rotating cylinder could be made to give a much greater lift for the same projected area than any ordinary wing yet devised.



A suggestion for testing the application of the Magnus effect to the airplane. The rotor could be driven by gearing or chain drive from the motor, or by an auxiliary windmill

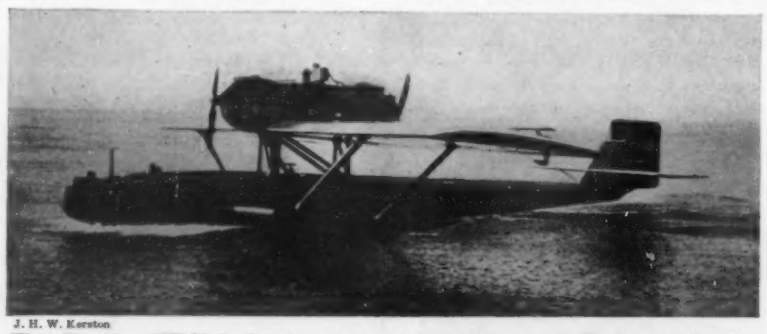
A rotating cylinder aircraft would, therefore, be smaller and more compact than the airplane. But what would be the efficiency of lift or drag? Very poor in all probability. The great lift is produced by violent, artificial disturbance of the air, and the efficiency must be less than in the fine streamline effects of a modern wing. Much experimentation in the wind tunnel is necessary before the question can be decided.

this device, by turning a crank, a high velocity is imparted through gearing to a flywheel. By a suitable tripping device, this flywheel can be engaged with the crankshaft and its stored up kinetic energy spins the engine and starts it immediately.

Anti-knock Fuels

THE higher the compression ratio in an engine cylinder, the greater the efficiency and the power developed, for a given amount of fuel. Thermodynamics and commonsense considerations both tell us this. But the difficulty is that, as the compression ratio is increased, temperature and pressure at the end of compression are both increased and pre-ignition or knock will be the result. This effectually puts an end to thoughts of still higher compression.

Certain blends of fuel seem to be better from the point of view of anti-knock than straight gasoline. A blend of benzol, alcohol and gasoline serves the purpose, but does not give easy starting or smooth running. Benzol-gasoline compounds are not satisfactory because benzol is rare, and also because it tends to crystallize out as ice at low temperatures. Lieutenant Commander E. E. Wilson in the course of the lecture to post graduate students at Annapolis, insists on the importance of finding just the right mixture or compound.



J. H. W. Kerston

This Dornier "Wal" hydroplane is equipped with two Rolls Royce "Eagle" engines of 450 horsepower each. The tandem arrangement of the engines enables the machine to fly perfectly with only one motor going

A Novel Starter

DURING the war and even a year or two after, it was a curious and somewhat thrilling sensation to see an airplane engine started. Three or four men would form a line, joining hands. The end man would grasp the upper blade of the propeller and pull down; the entire line would help pull him out of range of the immediately whirling airscrew. The maneuver required skill and speed, and often proved disastrous. For the most part, starters have displaced this somewhat crude practice, usually electrical starters are employed.

The Navy Bureau of Aeronautics, however, does not favor the electric starter because of its weight and complication. For small engines the Navy specifies a hand starter, which is well geared down and can generally be worked from the cockpit, without difficulty. For larger units the Aeromarine Company has recently developed a so-called inertia type starter, which is as ingenious as it is effective and simple. In

By Airship to Bermuda

BY provisions of the Versailles Treaty, the Navy Department cannot use the Los Angeles for military purposes. But it is employing the airship in a series of systematic flights designed to extract all possible information for the commercial exploitation of these giants of the air. The recent round trip from Lakehurst to Bermuda and back was one of these carefully planned trips. The flight was particularly interesting because, for the first time in American aviation, foreign mail was being carried by air. A brief announcement by the Post Office Department a day or two

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before sailing brought 2,200 letters, 138 postcards and some registered packages.

Leaving Lakehurst on Friday at 3:40 P.M., the Los Angeles picked up speed a few minutes after rising, and passed over Barnegat Light on the Jersey Coast at fifty-five knots, with only four of her five engines running. Her action was steady and without vibration, giving the sensation of "riding in a Pullman car over a fabulously smooth roadbed."

Rear Admiral William A. Moffett was on board. In speaking of the trip he said: "I am fortunate enough to be on this ship which will make the trip in probably twelve hours, and will get back to Washington Sunday night, having lost only one day at my desk and having two in Bermuda. This is only a forerunner of what anyone may enjoy in a few years."

Courtesy of Bermuda Trade Development Board

The Los Angeles over Hamilton, Bermuda

The Admiral was destined to be somewhat disappointed. Officers and crew enjoyed excellent meals, with navy beans as an essential ingredient. They slept comfortably when not on duty, and the only restrictions were absolute prohibition of smoking and rigid orders to throw nothing overboard (lightening of the ship entailing loss of helium later). But the airship soon ran into a series of fogs, then drizzling rain and finally a heavy downpour. When the Los Angeles reached Hamilton harbor in the small hours of Saturday morning, the envelope had soaked up so much water that the airship was heavy and waterlogged.

the mast of the S.S. Patoka, but to turn back immediately to the United States. Despite bad weather and fogs on the return trip the Los Angeles reached Lakehurst soon after midnight on Sunday, after thirty-three hours in the air and about twenty-eight hours actual flying time, at an average speed of some fifty miles per hour.

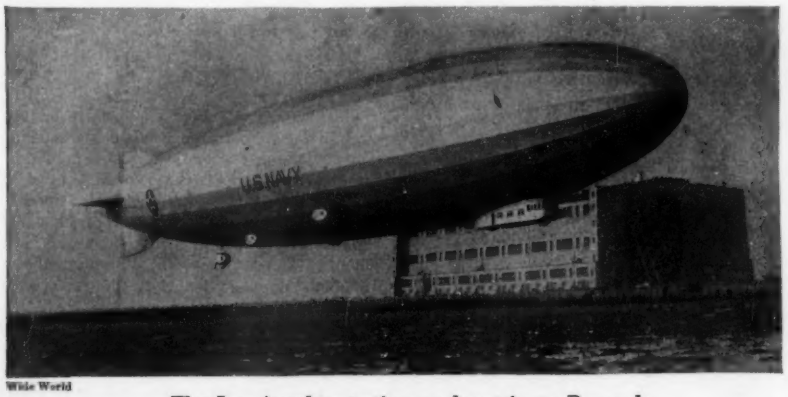
The official report said: "the trip, although only partially successful, showed the practicability of navigating airships at night, or at any other time, across the sea, and their ability to keep the air in bad weather." The soaking of the envelope, nevertheless, stressed one of the serious difficulties of airship navigation.

The Metal-covered Airship

THE elimination of water soaking and a general improvement in the resistance to weather conditions are among the advantages sought by the builders of the metal-covered airship. Ralph Upson, Chief Engineer and originator of the metal-covered airship, is a graduate of Stephens Institute. Although only thirty some years of age, he possesses an enthusiastic, inventive mind combined with the analytical faculties of a well trained engineer.

With the backing of Henry Ford, his company the Airship Development Corporation has done an enormous amount of experimental work, and has now received an order from the United States Navy for the first metal-covered airship. This order is for a comparatively small ship some 200,000 cubic feet in volume, with a length of 150 feet and a maximum diameter of 53 feet. In these dimensions themselves an extraordinary development is apparent.

When Count Zeppelin built his early airships, they were long cylindrical affairs, rounded off at bow and stern, with a length some ten or eleven times the maximum diameter. Gradually, it was realized that the long cylindrical shape was far from being the best, and particularly in non-rigid ships the fineness or ratio of length to diameter went down to five or six. Even in rigid airships the fineness ratio has diminished considerably (for example, the Los Angeles, recently built in Germany, is of better streamline form and thicker amidships in proportion to its length than is the Shenandoah built at Philadelphia and Lakehurst). Still it is quite revolutionary to have the designers of this new metal airship claim that a ratio of length to a maximum diameter of less than three really gives the shape which has the least resistance for the same volume of gas.



Wide World

The Los Angeles starting on her trip to Bermuda

The lift of an airship is due mainly to the buoyancy of the helium or hydrogen in her huge gas cells, but some lift is also available from the dynamic action of the air on the hull and tail surfaces. If the Los Angeles had stopped her engines, she would have lost this dynamic lift and alighted with too much of a bump for either comfort or safety. The bump could have been avoided by letting out water ballast, but this would have meant letting out much of the precious helium gas later when the ship had dried out.

Heavy winds complicated the problem. It was decided, therefore, not to wait for the ship to dry out and to attempt mooring at

Wherein lies the explanation of this remarkable development? Partly in extremely skilful aerodynamic design of the short hull and partly in the fact that the shorter airship form has a smaller surface for the same volume, so that the skin friction is considerably diminished. Of course, there must be a limit to this shortening up process. A sphere indeed would have the least possible surface and skin friction for a given volume of gas, but it would create greater turbulence in the air with much more head resistance, so that the total resistance would be much greater.

In some respects the new design does not depart greatly from ordinary non-rigid prac-

Material Handling Hints for 1925

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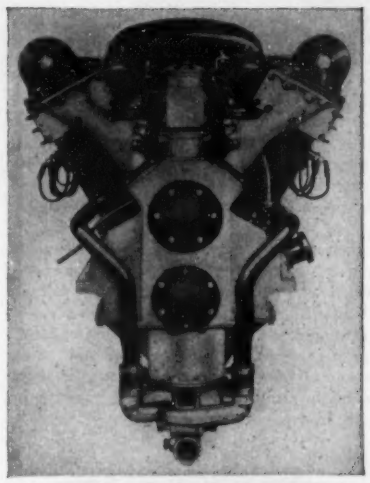
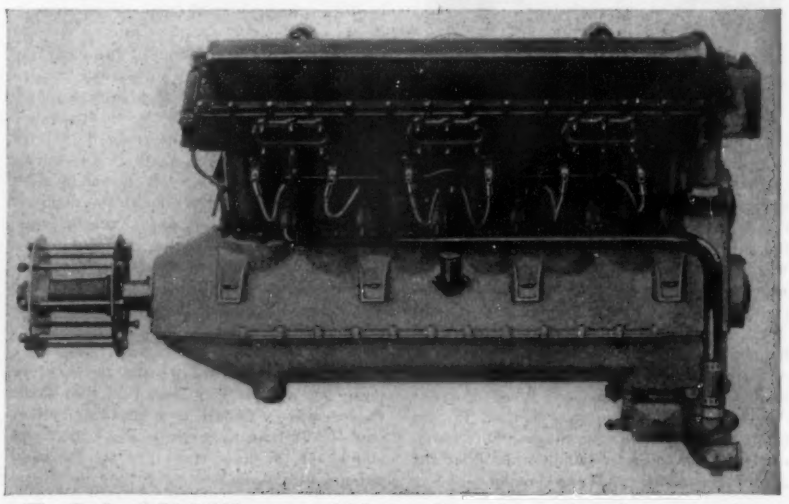
tice, but there is considerable novelty in the above small fineness ratio and in the replacement of rubberized fabric by aluminum sheets some eight or ten thousandths of an inch in thickness. Experiment has shown that these sheets have only one-tenth the permeability of ordinary rubberized fabric and have infinitely better resistance to weather. The riveting together of these thin sheets solidly and quickly has led to the devising of special machinery and of a special caulking which eliminates leakage at the joints. The thin sheets are backed up by very simple girder shapes running longitudinally and transversely. Apparently no greater difficulty is found in cutting out and riveting the thin sheets to the form required than is found in handling the fabric covering of an ordinary airship. Our guess would be that in such a comparatively small ship the weight of even the thin sheets would run heavier than the fabric. No doubt there are certain compensations in the absence of local patches and reinforcements. Also with the very large diameter available it is not necessary to suspend the car to get the center of gravity below the center of buoyancy of the gas, and the car is streamlined in to the hull accordingly.

For gas control, a single fabric ballonet is enclosed within the envelope, filled with air at ground level and shrunk to nothing at altitude, when maximum gas displacement is required to compensate for the lesser lift of the rarefied atmosphere. With two 200-horsepower, air-cooled Wright Whirlwind motors a speed of seventy miles per hour is expected with this comparatively small ship.



The smaller of the new Packard airplane motors which turns up 500 horsepower at 2,000 revolutions per minute

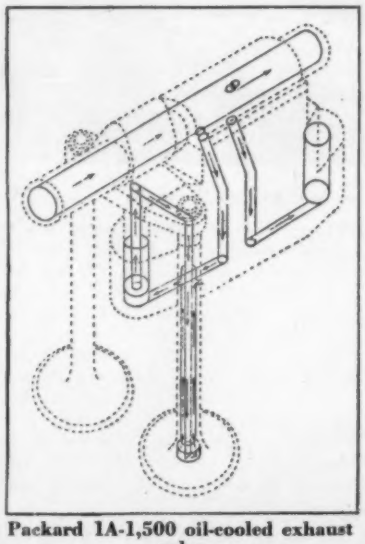


The Packard 1A-2,500 motor which is well on the road to the aero-engine designer's dream of one pound per horsepower

One Pound per Horsepower

AN airplane engine must be capable of delivering its maximum power for long periods. It must have instant pick-up, minimum fuel expenditure, great endurance, ready accessibility, compactness and, above all, it must have light weight per horsepower.

The outstanding achievement in this field during the last twelve months lies, perhaps, in the completion of two Packard engines of 500 and 800 horsepower, respectively. A 1,000 horsepower locomotive weighs in the neighborhood of 100 tons; the engine of a Ford car weighs over 200 pounds and delivers but little over 25 horsepower; the Liberty motor, of war fame, turns up 400 horsepower and has a weight of approximately 840 pounds.



Packard 1A-1,500 oil-cooled exhaust valve

The two new Packard engines are on the road to the aero-engine designer's dream of one pound per horsepower. The smaller of these motors, termed the 1-A-1,500, because it has a displacement of 1,500 cubic inches, actually turns up 500 horsepower at 2,000 revolutions per minute and weighs only 730 pounds. The larger of the two, termed the 1A-2,500, develops 800 horsepower at the same speed of revolution and weighs 1,072 pounds, or only 1.34 pounds per horsepower. The new 500-horsepower motor actually occupies far less space than the old Liberty motor and, therefore, offers less head resistance when installed in an airplane. Both engines have successfully passed block tests of sixty hours at full power, in normal and in inverted positions.

Wherein lie the reasons for these wonderful figures? Not in any revolutionary changes, but in steady development and improvement of every feature of the engine.

Increased power is obtained first of all by speeding up. Two thousand revolutions per minute is an enormous speed for engines of this power—probably the fastest speed in the world for a primary power unit of this size. The bore-stroke ratio is one, so that the height is as small as possible; the distance between cylinders is reduced to a minimum so that the length is equally re-

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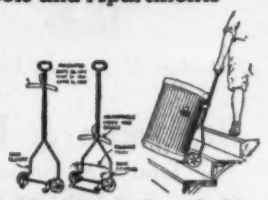

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duced. Both these features cut down the weight by reducing the unsupported length of crankshafts. An overhead camshaft reduces weight by eliminating the push rods in evidence on even the best automobile engines. A novel double magneto and a neat arrangement of the distributors in the center of the Vee of these twin-six motors, results in a saving of about half the magneto weight without any loss in dependability.

The enormous power developed in such a small volume means that an equally enormous amount of heat has to be got rid of. The exhaust valves accordingly are subjected to very high temperatures, and the Silchrome valves employed are actually cooled by a novel system of oil circulation, as shown in our diagram. The cooling of the exhaust valves results in a much greater reliability of the entire valve system.

Future Engine Developments

THE two Packard engines described above are not the last word possible in aero engines. Lieutenant Commander E. E. Wilson, in a brilliant lecture to post graduate students at Annapolis, makes some striking, yet well founded predictions, and discusses several interesting novelties. Experiments are being made with a so-called barrel-type engine with an oscillating plate replacing the usual reciprocating parts, which has a frontal area of only a fraction of that of the more conventional type of engine.

Also, an air-cooled engine of four radial cylinders is being developed, which has a large cam and rollers replacing the usual crankshaft and connecting rod, with a form of Scotch yoke keeping the four pistons in synchronous movement. The cylinders can be placed very close together in this arrangement and, therefore, great compactness is secured. This is a great advantage for the air-cooled motor whose enormous projected area and large head resistance are its main drawbacks.

As in marine practice, the aero-engine speed is necessarily high to meet the requirements of economy and weight. Direct-driven propellers are not common in marine practice, and, similarly, when the aero engine speeds up to 3,000 revolutions per minute, it will be impossible to co-ordinate the enormous rotational velocity of the propeller with the forward speed of the airplane. A two to one reduction will then most certainly have to be incorporated in the design. To date the torsional vibrations in the crankshaft have made gearing unreliable, and the additional weight of the reduction gearing has counterbalanced most of the gain in propeller efficiency. A new gear, having a flexible coupling between the gear and the crankshaft to absorb torsional vibrations, seems to have solved the problem, and new engines for duty in heavy, comparatively slow seaplanes are being geared down.

Hitherto, superchargers have been used only to maintain the power of the engine at altitude. With such enormous speeds as 3,000 revolutions per minute, it may become impossible to supply sufficient air through the inlet valves unless a supercharger is incorporated, capable of supercharging the supply of air in proportion to the crankshaft speed.

Inverted engines are attracting considerable attention. An inverted engine delivers somewhat more power than an ordinary engine, because the heavier, cooler water in the cylinder jackets is now nearer the inlet valves. The inlet end of the combustion chamber is cooler, therefore, and more fuel is taken in per stroke.

The inverted engine, however, has more important advantages for airplane use. It provides better vision for the pilot, who sees the cowling of a narrow crankcase in front of him rather than that of the projecting cylinder heads of a Vee engine; it raises the thrust line of the propeller thus improving longitudinal stability and giving greater propeller clearance, or a shorter landing gear, as desired. There is the problem of oiling, which, however, requires considerable care in such inverted engines.

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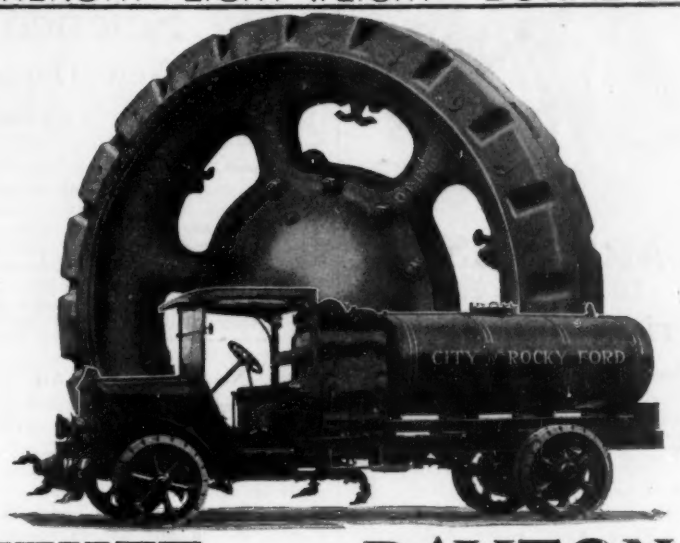

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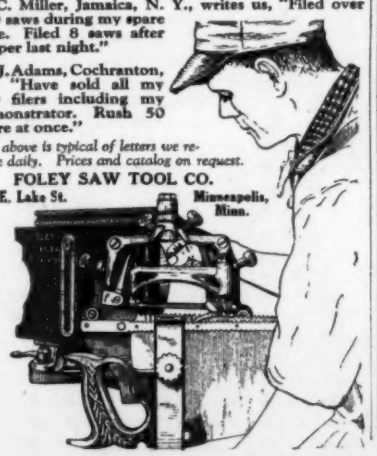

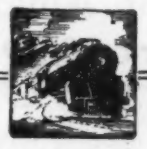

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Science and Money

A New Department for Investors

Conducted by E. E. Free

This department of scientific news having interest for investors was begun in the Scientific American for April, 1925. It is devoted to basic scientific facts which affect—or may affect—security values or financial movements. So far as possible such general questions from readers will be answered in these columns. We cannot answer questions about individual companies, securities or investments. Ask these questions of your banker. Our job is to tell you what we can of the scientific possibilities or impossibilities, of the general trends and prospects of industry and discovery.

No Sugar from Air

SOME months ago Professor Baly of Liverpool University read a series of scientific papers in which he announced that he had been able to produce a variety of sugar (corn sugar or glucose) by the action of ultra-violet light on certain simple chemical substances, the ultimate starting points being carbon monoxide gas and water. From this statement some of our readers have assumed that synthetic sugar, made freely and cheaply from coal or wood and from air, is just around the next turning of the road of scientific progress.

Unfortunately for those whose sweet tooth is hampered by the price of sugar, this is far from being the case. It is not certain that Professor Baly's experiments are correct at all. His conclusions have been attacked by eminent American chemists working in the same field. Even if Professor Baly is right, the cost of the ultra-violet light needed in his process is many times the cost of sugar made in the ordinary way by the living cells of plants.

The most efficient sugar factories now in existence or in sight are those in the sugar cane, the sugar beet and similar growing plants.

The Use of Oil

THERE are two developments which are coming on rapidly and which are bound to affect, more or less seriously, the oil industry of the world. One is the growing importance of the Diesel engine. The other is the progress being made in the chemical study and utilization of oil.

The Diesel engine is nothing new to readers of the Scientific American. It has been in use for years. It is increasing in importance, both as regards the number of engines in use and the size of the units employed. The Diesel principle has been applied successfully to marine and to stationary engines. Diesel locomotives are in use. An airplane engine on the Diesel principle is reported to have been constructed.

This Diesel principle, so far as the oil industry is concerned, may be set down as the direct use of crude oil to produce power. It contrasts with the steam-boiler principle, in which the oil is burned in a furnace to make steam, and with the internal-combustion principle, in which the oil is first converted into as much gasoline as possible and this gasoline is then used to drive the engine, as in ordinary automobile engines. The Diesel principle is more efficient than either of the others. It yields more power from the same quantity of oil.

The net effect of this on the oil industry will be, however, an increase of the oil used for power production, not a decrease. The greater efficiency of the Diesel principle means that oil will replace, to some extent, the coal, wood and other fuel now used in steam plants to produce power. This means, therefore, a greater market for crude oil, a stabilization of the oil producing industry, a lessened dependence of the profits of oil drilling upon the use and production of refined gasoline.

The effect of the prospective chemical utilization of crude oil is the same but is much less immediately in prospect. It is true that oil contains many substances which the chemists can extract and convert into useful things. It is nearly as great a storehouse of chemical raw materials as coal tar proved to be a generation ago. It has been said, and it is probably true, that oil is far too valuable a thing to be burned up at all. It should be kept for chemical use.

But that is far ahead. At present, most of the oil that comes out of the wells will be used, directly or indirectly, for the production of heat or power. The Diesel development will make this use more direct; less dependent on the refining of gasoline.

Interpreted in terms of finance, this is likely to mean benefit for everybody. The price of crude oil is likely to be more stable, less affected by the inevitable short-time variations in the drilling or flow of wells—that is, of oil production. But it must be remembered that the unexpected discovery of new oil fields, with its consequent excessive drilling and over production, will be sure to affect oil prices downward, regardless of the increased stabilization which the Diesel engine may create.

Wheat and Weather

ONE of the most desirable things that science could do for finance would be to provide some reliable method of long-range weather forecasts. The wheat crop, for example, is among the most important elements of the annual financial situation. The amount of this crop is not known in advance. It can only be guessed at.

But the amount of the crop is determined almost entirely by the number of acres planted and by the weather. A reliable weather forecast, made six months in advance, would stop most of the speculation in wheat and would be a great factor in stabilizing all financial movements.

There is some chance that such long-range forecasts will prove possible. Recent work by the Smithsonian Institution indicates that the day-by-day variations in the amount of heat received from the sun have an effect on the weather. The sun's variations are more or less regular. Possibly they can be predicted. Details are still uncertain and remain to be worked out. But there is hope that wheat speculation will ultimately be directed or prevented by scientific weather data.

Perpetual Motion Again

THE old dream of perpetual motion is turning up once more, this time in the disguise of wonderful, recently discovered "atomic forces." By "radio engines," "vibration motors" and the like an inexhaustible source of power is supposed to be put on tap for the fortunate purchasers of these schemes and investors in their so-called securities.

Now the dangerous thing about such claims as this is that they are partly true; just true enough to attract some attention from persons who have a little knowledge of recent atomic discoveries. It is quite true, for example, that a quantity of radium may be sealed up in a vacuum with a small wind vane or some similar device and will then keep the vane moving, not, it is true, forever, but for perhaps two or three thousand years.

Practically this is of no importance. The radium costs a fortune and the energy slowly set free from it—which energy it is that

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oves the vane—is extremely small in mount. All the known radium in the world ould not give off energy enough to run a nall sized motor. There is not the slightest vidence that any source of "atomic" or vibrational" power will be discovered in the oms of matter in general, or that the long-me motion which can really be attained y radium and similar chemical elements will ever have any practical value as a source of useful power.

The position of science is still what it has been for many decades. Perpetual motion, in the sense of a machine which will produce useful power out of nothing, is believed to be impossible.

Make no investment, directly or indirectly, in any such machine or any such idea.

The Heavens in May

By Professor Henry Norris Russell, Ph.D.

At 11 o'clock: May 7.
At 10½ o'clock: May 15.
At 10 o'clock: May 22.

At 9 o'clock: June 7.
At 8½ o'clock: June 14.
At 8 o'clock: June 22.

At 9½ o'clock: May 30

The hours given are in Standard Time. When local summer time is in effect, they must be made one hour later: 12 o'clock on May 7, etc.

NIGHT SKY: MAY AND JUNE

The Heavens

IN our survey of the skies this month, we may well begin with the Great Dipper, which is very high in the north, with the end of its handle almost overhead. The curve of the handle extended southward leads to Arcturus, the brightest star in this part of the sky. Below and to the right is Spica, which looks less than half as bright as Arcturus but is much farther away and really brighter. Far down on the left is Antares, the great red star in Scorpio. On the line between this and Spica, but nearer the latter, is the planet Saturn which is brighter than either.

In the west we find Regulus well down toward the horizon, and in the northwest Castor and Pollux, very low, and Capella setting. Deneb (Alpha Cygni) and Vega are in the northeast and Altair low in the east. The remaining constellations may be found at once with the aid of the star map, when these bright stars have been located.

The Planets

Mercury is a morning star in Pisces and Aries, and is visible before sunrise all through the month—best about the 16th when he is at his greatest elongation, nearly 26 degrees from the sun. At that time he rises a little before 4 A.M. and should be easy to see, as he is of the first magnitude and much brighter than any star in the vicinity.

Venus is now an evening star, theoretically, but is so close to the sun that she can hardly be seen except at the very end of the month, and even then she sets only three-quarters of an hour after sunset. Mars is also an evening star in Taurus and Gemini, and sets about 10:15 P.M. in the middle of the month. He is less than half as bright as Aldebaran, and is no longer conspicuous, though easy enough to see.

Jupiter is in Sagittarius, rising just after midnight when the month begins and shortly before 10 P.M. at its close, and is the brightest thing in the morning skies.

Saturn comes to opposition on the 2nd, and is visible all night long. He is in Libra, and much brighter than any star in the neighborhood—brighter, indeed, than he has been for about ten years, since his rings are seen at a wider angle and send us more light. He is, as always, one of the most beautiful of telescopic objects, if one has a telescope of six inches or more of aperture to view him with. His largest satellite, Titan, which is rarely visible in such a telescope, may be found north of him on the 3rd, east on the 7th, south on the 11th, west on the 15th, and so on, at intervals of sixteen days. When east or west the satellite's apparent distance from the planet is about five times the greatest diameter of the rings; when north or south only one-third as much.

Uranus is in Pisces, and rises about 2 A.M. Neptune is in Leo, and is in quadrature east of the sun on the 11th, so that he is visible all the evening. The moon is full at 9 A.M. on the 8th, in her last quarter at 1 A.M. on the 15th, new at 11 A.M. on the 22nd, and in her first quarter at 3 P.M. on the 30th. She is nearest the earth on the 11th and farthest away on the 27th. During the month she is in conjunction with Neptune on the 1st, Saturn on the 7th, Jupiter on the 12th, Uranus on the 17th, Mercury on the 20th, Venus on the 23rd, Mars on the 25th, and Neptune again on the 29th.

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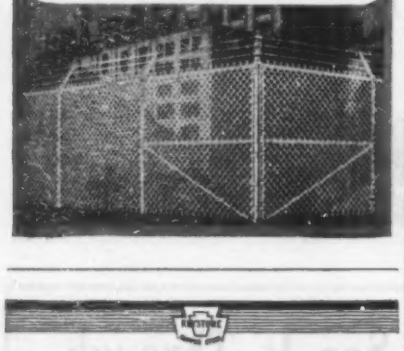

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Radio Notes

A Review and Commentary on the Progress in This Branch of Rapid Communication

Conducted by Austin C. Lescarboura

Some Difficulties of the Superheterodyne

THE present popularity of the superheterodyne receiver is proof enough of its value. However, it is just as fair to admit that in some instances the very sensitiveness of this type of receiver proves somewhat of a disadvantage.

First of all, the superheterodyne receiver is so sensitive that it picks up all manner of parasitic disturbances. The operation of an electric motor in the house is sufficient to cause a powerful disturbance in the superheterodyne receiver. The same may be said for the usual bell wiring, telephone wires, defective electrical devices, flashing signs, violet-ray machines and so on. An X-ray machine will disturb superheterodyne receivers over a range of miles. We know of superheterodyne receivers which have picked up the ignition sparks of an automobile engine a hundred feet or more away.

Then there is the matter of shielding. The loop of the superheterodyne is generally quite directive. Indeed, two stations operating simultaneously on precisely the same wavelength can be separated simply by the directional adjustment of the loop. However, in the presence of large masses of steel, such as gas tanks, steel work of buildings, water tanks, safes and so on, the directional effect of the loop is generally destroyed. The author has noted the peculiar influence of the steel framework on a superheterodyne receiver. Thus, the loop, which would normally be pointing edge on toward the broadcasting station, may be pointing at right angles to the usual plane for the best results, because of the steel framework. Moving the loop about the room in a skyscraper discloses a vast difference in the intensity of the signals. When the loop is directly above or below a steel beam, the signals are loudest. Again, the loop sometimes has to be pointed end on toward a window for the best results.

Before deciding on a superheterodyne receiver, the radio enthusiast should insist on a trial if the set is to be used in a building with steel framework, or in close proximity to large masses of steel or other metal.

Useless Solutions for Storage Batteries

FROM time to time there have appeared on the market various kinds of useless solutions for storage batteries, the avowed object of which is to "pep" up the usual storage battery, or to recharge it without the necessity of the conventional and slow charging process. "Just pour out the old solution and pour in the special solution to recharge your battery," or words to that general effect, explain the claims made for these various solutions.

Anyone with a fair knowledge of what happens in the storage battery, from the time it is fully charged until it is fully discharged, knows that an intricate chemical change takes place, not only in the electrolyte, or liquid, but also in the plates. It is this chemical change which generates the electric current that we get out of the battery. It is to reverse this chemical process and to get the chemical condition of the battery back to its original status that we recharge the battery. Merely a change in the electrolyte or liquid fails to accomplish the necessary chemical change.

The Bureau of Standards has looked into this matter of special storage battery solutions and has published its findings. Analysis revealed these special solutions to contain 38 to 42 percent of sulphuric acid, which is about the amount in the electrolyte of an automobile battery when charged. In some of them were found significant amounts of sodium or magnesium, as well as coloring matter. The sodium may have been added as soda, lye or Glauber salts; the magnesium as Epsom salts. The use of sodium sulphate in batteries is an old story. It was suggested more than 35 years ago.

The experiments disclosed no essential difference between a battery containing one of the "trick" solutions and one containing the standard electrolyte—simply distilled water and sulphuric acid. In some instances the "trick" solution will give the "dead" battery an extra spurt of life, just because the plates retain a surplus of active material. But when such a battery is recharged, the specific gravity will rise too high because the acid of the "trick" solution will be added to the acid already present as the normal result of recharging. Such an excess of acid will cause a material increase in the local action or self-discharge of the battery.

After all, there is one way to revive the "dead" storage battery: have it thoroughly recharged. If your home recharger does not make much of an impression on the battery, it is because the battery is too far run down and a higher recharging rate is necessary. In that event send it to the

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recharging station for the big boost, after which you can recharge it yourself as occasion demands.

The Passing of Radio Jazz

IN the course of his speech at a radio luncheon given by the Merchants Association, John A. Holman, manager of broadcasting for the American Telephone & Telegraph Company, said in part:

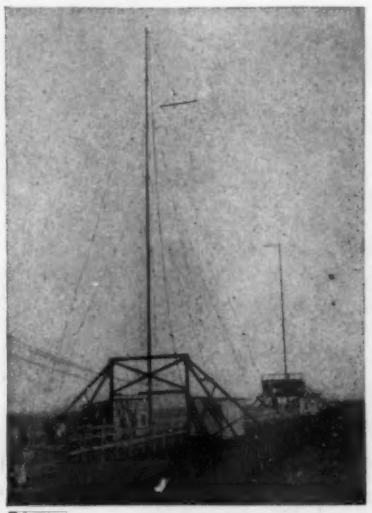
"Your letters to WEAF are analyzed very carefully and they are of great value to us in planning your future programs. Fifty-four thousand letters received in January, 1925, as compared with a monthly average of 17,000 in 1924, is an indication of the tendency in this direction. I believe that the tendencies with respect to programs will interest you. Here they are:

	JAN. 1923 Percent	JAN. 1924 Percent	JAN. 1925 Percent
Jazz	75	35	5
Symphonic dance	..	..	30
Good music.....	20	30	45
Talks	5	35	20

"In other words, in two years the demand for jazz music has shown a tremendous decrease, while the demand for the better class dance or symphonic dance music has shown a marked increase. Good music—that is, concert and standard numbers, philharmonic concerts and the like—are steadily growing in favor; and talks, inspirational, interesting and educational, are also more popular than they were two years ago."

Antenna Wire with Enamel Coating

RADIO authorities agree that ordinary bare antenna wire, when exposed to atmospheric fumes and moisture, deteriorates rapidly. Also, high-frequency currents in the antenna flow along the surface of the wire, and when this surface becomes corroded the antenna current encounters increased difficulty in reaching the radio receiver. This means loss of range and volume.



Fotogrsme

Palm Beach has radio station on pier

Just to what extent this is so it is hard to tell. However, it sounds plausible. For a long while back the most fastidious radio amateurs have used enameled wire for their antennas in DX work, especially in cities where the atmosphere is contaminated with sulphur and other corrosive fumes.

Now comes a stranded antenna wire made up of bright, clean copper strands, each covered with a protective, baked-enamel coating. Atmospheric exposure has no effect on the enamel. Corrosion cannot take place.

Perhaps the use of enameled antenna wire may be an instance of splitting hairs. But it is worth trying, especially by the DX hound.

The Mortality of Broadcasters

SINCE September, 1921, when broadcasting became an American Institution, 1,180 broadcasting stations have been on the air. At the end of a little more than three years, as these lines are being written, we find about 550 broadcasters still at work. Obviously, some 630 stations have ceased to broadcast for one reason or another. In some instances it has been lack of funds, for it costs a great deal of money to broadcast. In others it has been lack of returns, tangible or otherwise; in some it has been sheer lack of interest; in still others, it has been the misfortune of being squeezed out of the air by more powerful or more prosperous stations started in the same vicinity.

Courtesy of DeForest Radio Co.

Patriarch of modern advertising urges radio for those with an impaired sense of hearing

We may be duly thankful that all the broadcasters did not stop at one time, thus bringing our radio entertainment to a close. Fortunately, as one broadcaster after the other has signed off for the last time another broadcaster has made his initial bow to the radio audience. So it has been a case of coming and going all the while, with a highwater mark at one time of close to seven hundred. In 1922, 642 new stations opened and 94 dropped out; in 1923, 249 came on the air and 298 quit; and in 1924, up till November 30, 249 came on the air and 238 dropped out.

Low-wavelength Broadcasters

IN order to make room in the air for a large number of broadcasters, the Department of Commerce has assigned channels below 230 meters to Class A broadcasters. In some instances the assignments have gone down as low as 209 meters. At this writing we learn that already twenty wavelengths below 225 meters have been assigned. The lower limit recommended by the recent conference was 205 meters.

All of which has a definite bearing on our receiving sets. Most of the present-day receiving sets do not operate well below 230 meters—the designers never expected broadcasting to operate on lower wavelengths. Doubtless the receiving sets from now on will have some provision made for operation on these lower wavelengths. Meanwhile, those of us who have conventional receivers can tune in on these lower wavelength programs by cutting down the length of our antennas, decreasing the inductance in our receiving sets, or, what is usually the simplest practice, inserting a series condenser in the antenna circuit or in the ground lead. Such practices will enable the lower wavelengths to be intercepted over short distances. When it comes to DX reception of these lower wavelengths it is necessary to have a receiving set especially made to take them in.

Headsets Are Not Obsolete

WHILE admitting that radio broadcasting has now entered the loudspeaker era, the headset is by no means obsolete. Most people measure the value of a set by the number of distant stations they can log. If they have no headsets, they are not getting all of the stations they might get.

The headset can be used to tune in signals for loudspeaker reception. It can be used to get distant stations, both domestic and foreign. It can be used to shut out the noise in the room and get all the radio fun.

And with all due respect to your loud-

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Eveready Columbia Ignitor Dry Cell "A" Battery for all Dry Cell Tubes 1½ volts
No. 770 45-volt Extra Large Vertical Price $4.75 For use on multi-tube sets
No. 767 45-volt Large Horizontal Price $3.75 With variable taps

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speaker, you usually cannot get from it such realism and quality as you get from the telephones. Another advantage of the headset is that you can listen in without disturbing others. The good old headset is still of some use, after all.

An Exceptionally Low-loss Transformer

IN these days of low-loss excitement radio engineers are working night and day, so it seems, to bring radio losses down to the vanishing point. Another advance in the low-loss direction is a new low-loss transformer in which the coils are wound on quartz rods, while the end rings are of hard rubber. Quartz is an excellent insulator at all times and the rods retain their shape indefinitely.

In Defense of the Reflex Set

THE bugbear of reflex set building and operation is fast passing, due to the more adequate information which is now available. Radio enthusiasts are beginning to give it the full consideration which it deserves.

In the first place there is an immediate saving on tubes, for by using a crystal as a detector and returning the energy from one circuit and piling it on top of that in another, one tube can be made to do the work of two, and four or five tubes the work of seven.

Secondly, if the circuits are carefully designed to reduce the resistance and to increase the magnification of energy due to resonance, the tubes used may accomplish even more than those which they replace. This is only possible, however, when the set is built with all care to eliminate dielectric losses, wire losses and inductance interference, and to so arrange the apparatus that tuning is sharp and body-capacity negligible.

Besides the reduction in first cost and upkeep, due to fewer tubes needed, there is a direct saving in battery current, both "A" and "B."

F. M. Delano

Edouard Belin telling F. M. Delano, Scientific American correspondent, of his plans for his coming trip to America, before the telautograph stand at the recent radio show in Paris

With a reflex set selectivity and freedom from static may be readily increased by using a loop. This also does away with the necessity of stringing up an outdoor antenna of any kind and with the troublesome search for a good ground connection. The distortion and instability that are often attributed to such sets are caused, usually, by improper design.

Numerous Applications for German Patents

IT appears that the Navy Department is being flooded with requests from American radio manufacturers for the use of the German radio patents recently offered on reciprocal licenses. A standard non-exclusive, non-transferable but revocable license has been drawn up and will soon be submitted to applicants with a request for a list of their patents which would become available to the government. The process of going over the many applications and accompanying lists of patents would require considerable time, officials of the Navy Bureau point out, indicating that no licenses will be issued for several weeks to come. All applications will not be granted; probably only those firms having patents believed of value to the government will be cross licensed.

According to our advices, fifty-three applications already listed indicate that many new sets may appear in the near future, involving the famous Schloemilch-von Bronk reflex hookup, which is the best known of the German patents.

Scrambled Signals to Eliminate Static

IN a recent address delivered before the American Institute of Electrical Engineers in Cleveland, Dr. E. F. W. Alexanderson, well-known radio and electrical engineer, told of the latest developments in transatlantic radio communication. In part, he said:

"The fight against atmospheric disturbances and static has led us to build on Long Island a central receiving station with an antenna system consisting of two antennas ten miles long, joined by a transmission line. This seems like a large equipment, but its cost is insignificant in comparison with the service which it renders. This antenna system, known as the Beverage-Rice system, eliminates practically all static and intercepts on one antenna all the signals from all the stations in Europe. These signals are then automatically separated in more than a dozen receiving sets and sent by wire lines to the operating room in New York.

"There is only one kind of disturbance that this system does not practically eliminate, and that is a thunderstorm in the neighborhood of the station right on the line from which the signals come. To insure service even in this contingency, a similar large antenna system was built at Belfast, Maine, which would be immune to a thunderstorm on Long Island, whereas a station on Long Island would be only slightly affected by a thunderstorm in Maine. But the problem was how to get the signal down from Maine to Long Island. By painstaking work and many ingenious new inventions this has been done. The signals from Europe are picked out of the ether in Maine, scrambled together and sent out by a single transmitter. This composite signal is then received on Long Island and unscrambled into a dozen signals, which are fed into the long-wave receiving sets, where they go through the usual process of detection and transmission to New

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York. The signals so reproduced are exact replicas of the original signals, so that the operators in New York do not know whether they have received the original signals or the scrambled and unscrambled signals via Belfast."

A New Tube Design

SINCE the sole purpose of the filament current in the present vacuum tube is to heat the filament material and cause it to emit a flow of electrically charged particles it would seem that our radio technicians might work out some means of using the ordinary electric lighting current to heat a mass of metal without actually passing the current through that mass. Thus the customary hum of the current would not be imparted to the output of the vacuum tube.

It is reported that a vacuum tube designed along these general lines is soon to make its initial bow to the radio public. This vacuum tube will operate directly on 110-volt lighting current whether alternating or direct. It will have a standard Edison lamp base for the filament connections, while the plate terminal, the grid terminal and the cathode or electron-emitting member terminal, will come through the upper part of the bulb. The 110-volt current will serve to operate a heating element placed in a quartz tube or stem in the center of the bulb, surrounded by a sleeve of special metal which will serve as the cathode or electron-emitting member. It is understood that the quartz tube will be sealed to the bulb proper in such manner that the heating element may be withdrawn from the quartz tube or stem without breaking the vacuum seal. Thus, so we are assured, the resistance unit may be replaced at a very slight cost, and the tube proper will last indefinitely with such replacements of the resistance unit as may be necessary.

The Radiator Heater and the Sensitive Receiver

IT is common knowledge that hot-water or steam-heating radiators have aided broadcast reception by providing a fairly efficient ground connection. However, there are times when such a radiator—possibly it should be called a radio-radiator—is a great disadvantage to the successful operation of the sensitive radio receiver.

In the case of radio-frequency receivers which are highly efficient and super-sensitive, the presence of a large metal body, such as a heating radiator, ventilator, metal filing cabinet, stove, furnace and so on in close proximity to the receiver may possibly cause the receiver to become inoperative in whole or in part.

Again, although it may not be readily believed, the loudspeaker, if of metal and particularly if it has a large metal base and is placed on top of the receiver cabinet, may cause similar trouble. Another point to bear in mind in connection with the placing of the loudspeaker is that its cord should not run lengthwise of the receiver. If it does, there may be an undesirable coupling and energy transfer between portions of the circuit, with the result that there may be a considerable reduction of sensitivity and selectivity of the receiver and possibly inoperative conditions.

The Tube Testing Service

BUYING vacuum tubes today in a reliable radio shop is no longer like a grab-bag party. During the past few months the tube testing idea has come into general use, so that the buyer knows precisely what he is getting in the way of tubes. A large New York radio dealer now announces the last word in tube testing service, in the form of an elaborate array of meters and sockets.

This service measures the mutual conductance of the tube. That is, it tells the actual operating efficiency of the tube. It matches tubes to the same output per stage, assuring perfectly matched and balanced tubes for use in super-heterodynes, neutrodynes and other multi-tube receivers. It

What keeps this family so happy?

What is play in *your* family? What good fun do you have that is more than merely fun? Do your good times pay you dividends in more knowledge, more resourcefulness, more fitness for modern life?

Here is one American family that has found the answer. Look at the boy in this picture. Every healthy boy likes machinery, and wants to know what makes the wheels go round. Isn't this boy's occupation better for him than just casual loafing around the house, or aimless reading of a dime novel?

He thinks his work is fun—and it is. But all the time his home-made radio set is teaching him something that is good for his mind, in any event, and that will be of priceless value if he grows up into an engineer, or a manufacturer.

His mother has found something that interests her, too. It is a simple, understandable and authentic book on the great new science of psychology, which all her friends are discussing. And father is smiling over a book on mechanics; it is going to help him in a hundred ways, both in his plant and around the house and garage.

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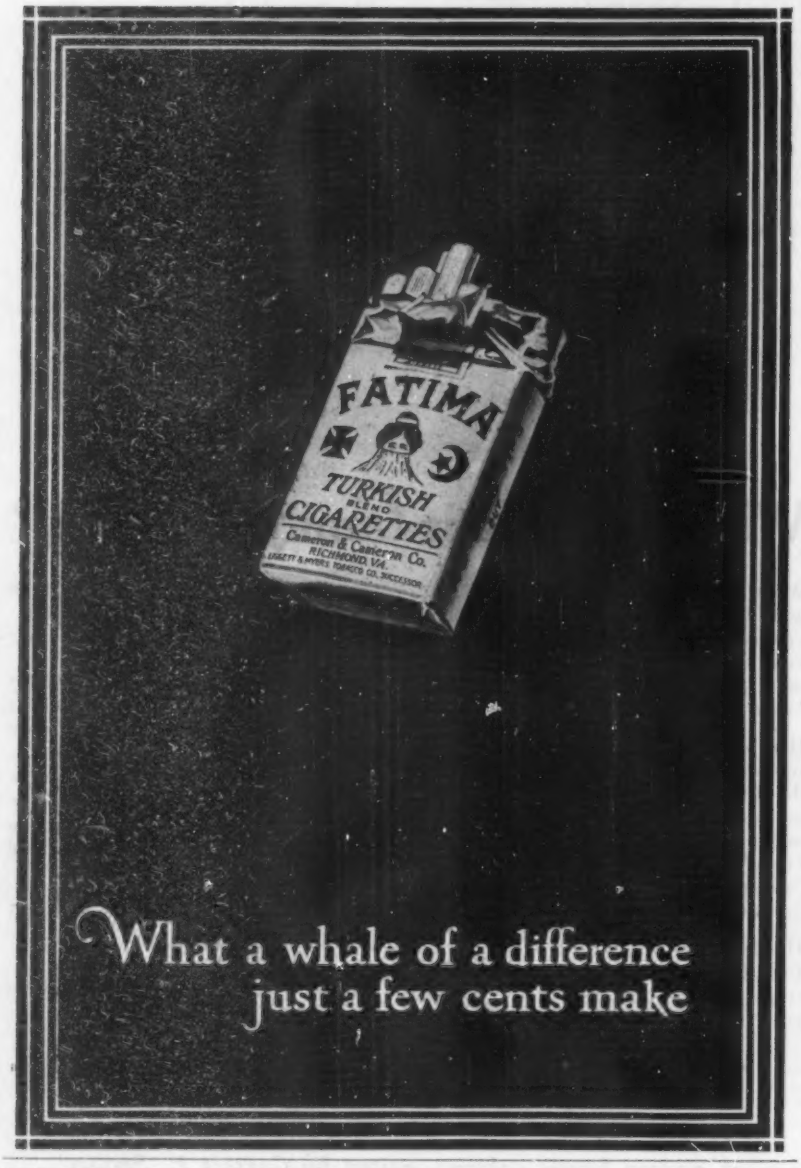

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The Majority Votes for Popular Songs

ACCORDING to records kept by station WSAI at Cincinnati, popular songs continue to hold a slight lead over jazz orchestras so far as the preference of radio fans is concerned. The standing to date of the five program leaders shows the following:

Popular Songs	896
Jazz Orchestra	814
Classical Orchestras	678
Sports	599
Theatrical Productions	447

While these figures apply to the programs of the WSAI station, they may be considered as fairly typical of the radio audiences throughout the country. The WSAI program department keeps careful watch over the cards and letters reporting reception of its programs, and senses the fluctuating likes and dislikes of its audience.

Fastening the Antenna to a High Tree

IT does make a difference whether the antenna is fifteen feet off the ground or thirty feet. So, it is altogether natural that most of us who live in the country where space is plentiful and where trees are not rare curiosities, should be anxious to swing our antenna between the house and the tallest tree in the vicinity. But how can we fasten the antenna to the topmost branch or trunk of that tallest tree? That is the problem—especially with us old fellows now on the wrong side of thirty-five but still young at heart where radio is concerned.

The author of these lines moved into a cozy little bungalow overlooking the Hudson River at its widest point, just four days ago. And today, with virtually everything else in place, the radio set had to be installed.

The only feasible place to swing the single antenna wire was between the chimney of the bungalow and a tall tree in the yard. Three attempts to climb the tree resulted in pitiful failures and drove home the point that we are not as agile as we used to be. We were just about ready to fasten the antenna to a point on the tree about twelve feet off the ground, when friend wife suggested a plan for throwing a line over the topmost branches and then pulling the antenna supporting wire up and over it. About forty feet of twine, an old sinker and two "tries" resulted in getting a line over the topmost branch of the tree. Then we pulled up the wire running to the insulator fastened to the antenna wire, and the job was done at least until the twine breaks!

Far-reaching Extent of Radiation Interference

ALTHOUGH radio has entered the present year with one of its problems still unsolved —how to eliminate interference from the radiating receiver—the matter is receiving a good deal of attention. Some localities are so troubled with the interference of radiating receivers as to make them unbearable. Especially is this true of the large centers of population, where the radio "gyp" has unloaded his inferior receiving sets and encouraged the making of one-tube squealers.

Recently there was conducted by the *Cleveland Plain Dealer* through station WTAM, an interference survey. Squeals started deliberately in Cleveland for test purposes, were heard over one-quarter of the American continent. They were picked up clear to the Atlantic Coast, and as far southwest as Texas. These tests were carefully conducted, so that the astounding findings as regard the distance spanned by the oscillating receiver may be considered authentic.

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Conducted by Albert A. Hopkins

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Advice to a Beginner in Mechanical Drawing

S. Y., Sr. asks: "*Will you please give advice as to what drawing instruments to use and the correct handling of the instruments which is understand very important?*"

ANSWER: In any craft, if one wishes to do good work, one must have good tools, so also in mechanical drawing, good work cannot be done without good instruments. There are offered for sale many cheap grades of instruments which are not worth buying, for they soon become out of order and adjustment and cannot be used for accurate and neat work. It is not necessary, however, for the beginner to buy the most expensive instruments, nor is it necessary to buy more than a few. The following list of instruments will fill the needs of the average draftsman. These instruments are shown in Figure 1.

A—6-inch compass, with lengthening bar and pen attachment.
B—6-inch dividers, with hair spring adjustment in one leg.
C—Bow pen.
D—Bow pencil.
E—5½-inch ruling pen.
F—6-inch, 45 degree, transparent triangle.
G—8-inch, 30 x 60 degree, transparent triangle.
H—12-inch architects' or mechanical engineers' triangular scale.
I—5-inch semicircular protractor.
J—Drawing board, 23 x 31 inches.
K—T-square, 36 inches long.
L—Dozen thumb tacks.
M—4H drawing pencil.
2H drawing pencil.
N—Ruby eraser.
P—Erasing shield.

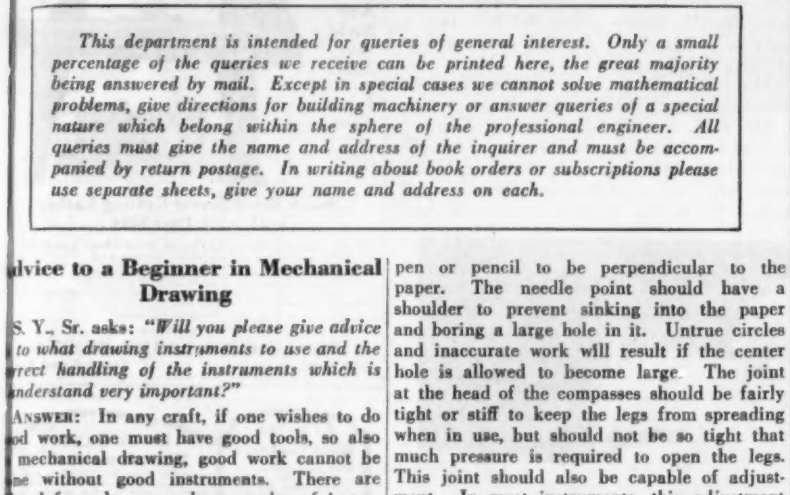

Fig. 1.—Necessary instruments for mechanical drawing

There are numerous other and special instruments that are in general use and very convenient to have at times, but which are not essential for the beginner in mechanical drawing.

Parallel ruler.
Sliding point pen.
Swedish ruling pen.
Proportional dividers.
Irregular curves.
Beam compass.

That they may be suitable for drawing all sizes of circles (within their limits), the compasses should have jointed legs, to allow the pen or pencil to be perpendicular to the paper. The needle point should have a shoulder to prevent sinking into the paper and boring a large hole in it. Untrue circles and inaccurate work will result if the center hole is allowed to become large. The joint at the head of the compasses should be fairly tight or stiff to keep the legs from spreading when in use, but should not be so tight that much pressure is required to open the legs. This joint should also be capable of adjustment. In most instruments, this adjustment is provided by means of a small screw with slotted head which can be tightened by means of a small screw driver. The cheaper grades of compasses have neither an adjustment in the head joint nor jointed legs.

The dividers should also have an adjustable head joint, but it is not so necessary that the legs be jointed. However, it is very desirable to have a hair spring adjustment on one of the legs which facilitates and saves considerable time in setting them accurately.

The drawing board should be made of clear white pine or poplar and should not be varnished or painted. Cleats should be fastened to the back by means of round head screws with washers under the heads. The holes in the cleats for the screws should be elongated, to allow the board to expand or contract with the weather without warping. The entire top surface of the board should be perfectly smooth and the ends finished perfectly true for the head of the T-square.

The straight edge of the T-square should not be set into the head but fastened to the top of it by means of screws and should be perfectly square with it.

USE OF INSTRUMENTS

The 6-inch compasses are used in drawing circles, 1½ inches or larger in diameter. When the spread of the compasses with the legs set perpendicular to the paper is not great enough to draw a circle of the required diameter, the lower part of the joint holding the pencil point is removed and the lengthening bar is put in its place and the piece holding the pencil point is then inserted in the end of the lengthening bar. The hinge being in the removable piece, allows the pencil point to be placed in a perpendicular position on the paper. Sometimes it is desired to draw circles of very large diameter and it then becomes necessary to use beam compasses, which are

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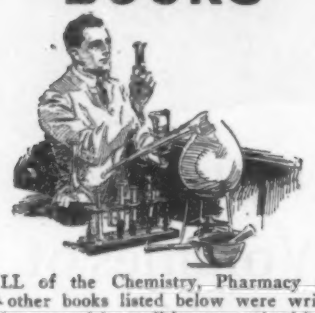

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nothing more than long strips of wood or light metal tubing with a needle point attachment at one end and a pencil attachment at the other end. The attachments are so arranged as to allow sliding them along the bar to set them at the desired distance apart. It is not often that one has use for a beam compass, unless laying out work to a large scale.

In using the compasses, they should be held very lightly between the thumb and forefinger and inclined slightly in the direction of motion. (See Figure 2.) Very little pressure should be used, as the legs will tend to spring and an inaccurate circle will result. In inking, the weight of the compasses alone is generally sufficient.

justment in one leg of the dividers is, therefore, almost indispensable for accurate setting of the points and saves a large amount of time.

The bow compass is used for drawing circles and arcs of circles whose diameters are less than 1½ inches, while the bow pen is used for inking them. Figure 3 shows method of using the bow pen or pencil.

The ruling pen is used with the T-square or triangles for inking straight lines.

The scale is used for measuring distances or lengths of lines on the drawing. The ordinary triangular architects' or mechanical engineers' type has the following scales on it: 3 inches, 1½ inches, ¾ inch, ½ inch, ⅜ inch,

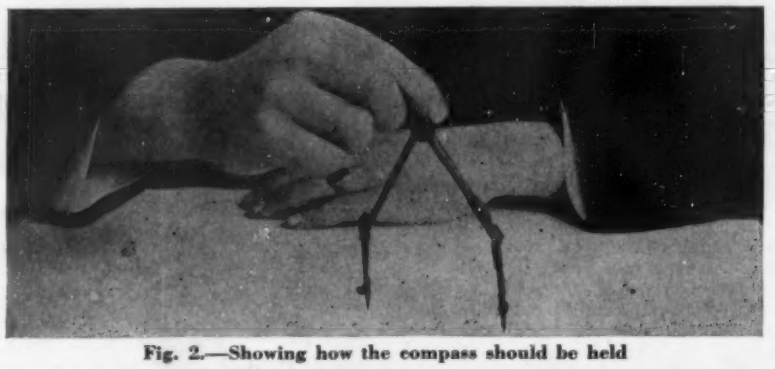

Fig. 2.—Showing how the compass should be held

Fig. 3.—Showing how bow pen or pencil is held

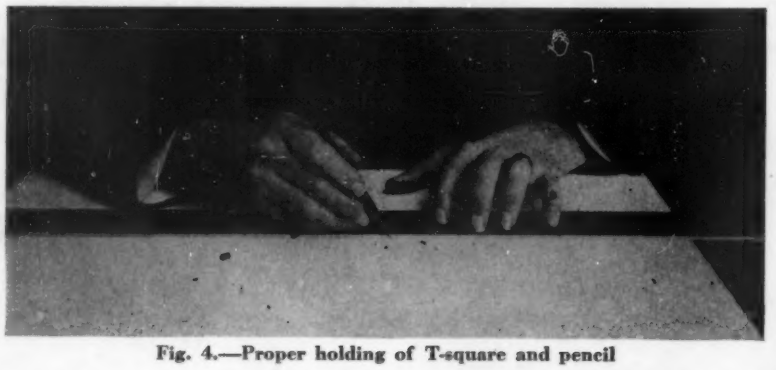

Fig. 4.—Proper holding of T-square and pencil

The dividers are used to set off equal distances or spaces. The points are set the desired distance apart, by means of the scale. The spaces or distances are then marked off on the drawing by placing the points of the dividers on the line to be divided, one point being placed at the end of the line. The divider is then rotated about each point successively. The instrument should be held very lightly, care being taken that only the very smallest and faintest marks are left on the paper by the divider points. Great care must be used to get the points set as accurately as possible, because a very small error in the setting of the points is multiplied by every space marked off, and this makes an appreciable amount in the end. In fact, it seldoms happens that the first setting comes out correctly at the end and it is often necessary to repeat the process several times to get the correct spacing. For this reason, the points of the dividers should leave no visible marks during the first trials, as the holes would become so numerous that one could not keep track of the correct ones. Besides, the points of the dividers would tend to fall into the holes previously made. The hair spring adjustment

¼ inch, 3-16 inch, ⅛ inch and 3-32 inch equals one foot. It also has one edge which is divided into inches and sixteenth of an inch. The scales that are most commonly used on drawings are ¾ inch to the foot or one-sixteenth size, 1½ inches to the foot or one-eighth size, 3 inches to the foot or one-quarter size, one-half size and full size. Full size and one-half size scales are used for details of small parts. For large structures or machines, it is necessary to use the very small scales to get the views within the bounds of the paper. When we speak of making a drawing, say to 3 inches equals a foot, we mean that each length or measurement of 3 inches on the drawing represents one foot or twelves inches on the object or structure. On our scale we find a length of 3 inches which is divided into twelve equal parts each of which represents an inch. By laying out our drawing using each one of these divisions as an inch, we have a drawing which is one-quarter of the actual size of the object.

The use of the triangles and T-square is shown quite clearly in Figures 6, 7 and 8.

The protractor is used for measuring or laying off angles other than those which are

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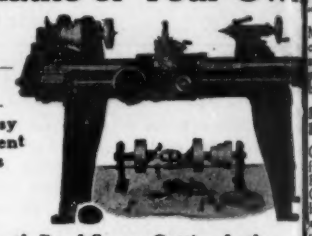

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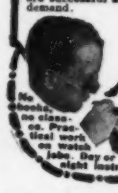

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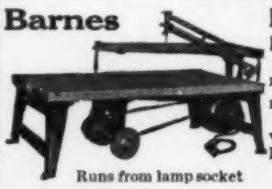

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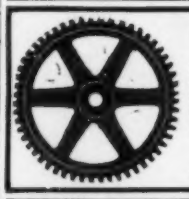

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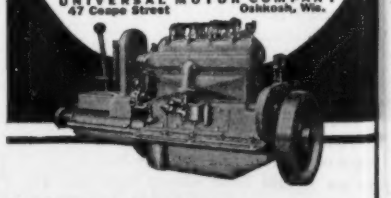

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PREPARATION OF PENCIL DRAWINGS

For general use, a drawing paper should be tough and have a surface that is not easily roughened or changed by erasing. A smooth paper is not good for pencil work. The sheet of paper should be fastened smoothly to the drawing board by means of thumb tacks, placed at the corners of the paper.

A pencil should be used that is not so soft that it will smudge and wear down quickly. For all-round work, a 4H pencil is the best to use. In drawing straight lines, many draftsmen use a pencil with the lead sharpened to a flat or chisel point. All lines should be drawn with the pencil slightly inclined in the direction of movement. The pencil should not be moved back over a line in the opposite direction as it might tear or plow up the surface of the paper. Draw horizontal lines from left to right and vertical lines from the lower edge of the paper up.

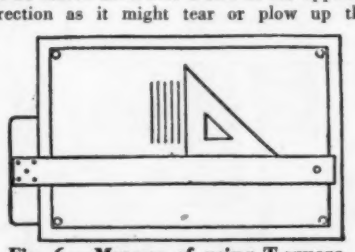

Fig. 6.—Manner of using T-square and triangle

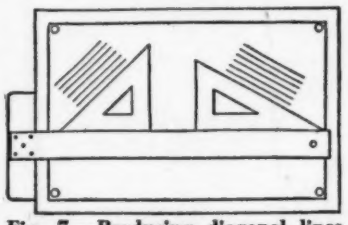

Fig. 7.—Producing diagonal lines with triangle

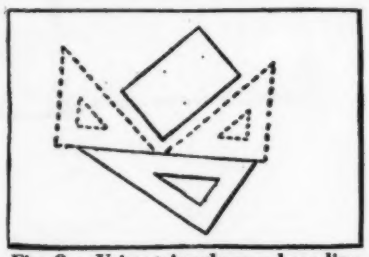

Fig. 8.—Using triangle as a base line for other triangles

Poor lettering spoils the looks of many a good drawing. The beginner in mechanical drawing should practice making figures and letters until he can make them uniformly and neatly, keeping them fairly close together. One of the tendencies of the beginner is to separate his letters too much. Fancy lettering is not essential for most work and, in fact, is not desirable on drawings for general use in shop or field. Fancy lettering is used on maps and by architects on plans of buildings.

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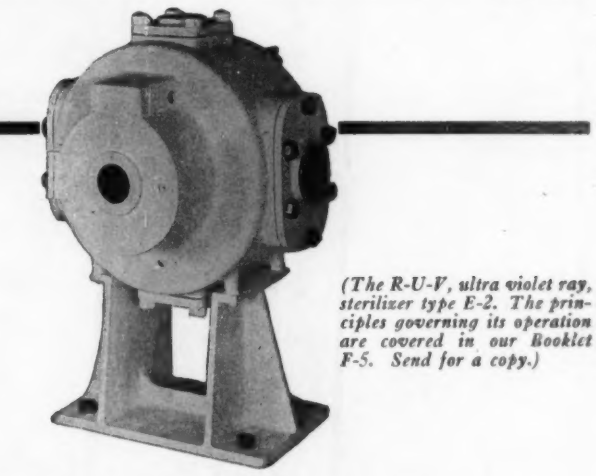

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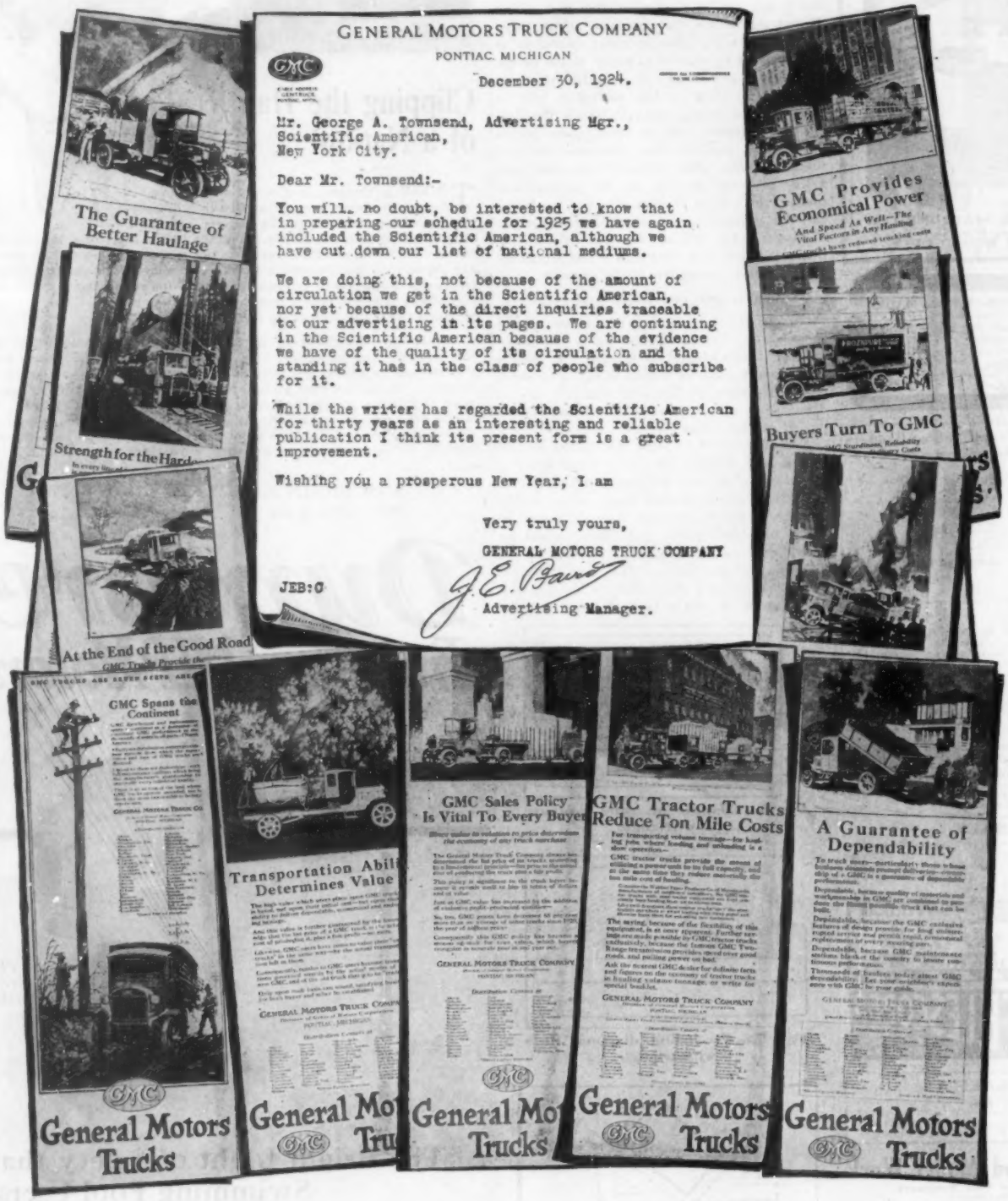
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CONTENTS
MAY 1925

ARTICLES

Muscle Shoals—Bonanza or White Elephant?—By Alfred P. Lane 293–295
A New Plan for Traffic Laws—By H. W. Slauson 296–298
Locust Fighting 299
Our Point of View—Editorials 300
The Marvelous Speeds of Atomic Particles—Full-page drawing 301
Saving St. Paul's Cathedral—By J. Bernard Walker 302–304
How the Average Man of Seventy-two has Spent His Life—Full-page drawing 305
Last Word on the 5-5-3 Ratio—By J. Bernard Walker 306–307
Did Man Evolve in Africa?—By Albert G. Ingalls 308–309
A Policy for the Conservation of Our Wild Game 310
A Bird Census—Full-page drawing 311
Mechanical Gas 312–313
The Manufacture of Thermometers—Page of photographs 314
Are There Other Habitable Worlds?—By Prof. Henry Norris Russell 315
Story of Steel 316–317
Mighty Hunters in the World of Ants—By S. F. Aaron 318–319
High-voltage Electric Laboratory at the California Institute of Technology 320
The "Margery" Mediumship"—By Professor William McDougall 339–341

DEPARTMENTS

Inventions New and Interesting 321–326
Recently Patented Inventions 327–328
News for Inventors—A new department 328
Scientific American Digest 330–338
Science Notes 341
Learning to Use Our Wings—A department of aviation 342–347
Science and Money—A new financial department 348–349
The Heavens in May 349
Radio Notes 350–354
Notes and Queries 355–357

INDEX TO ADVERTISERS

Absorbine, Jr. 340
American Blower Co. 335
Americana Corporation 352
American Lead Pencil Co. 344
American Pipe Bending Machine Co. 357
American Sheet & Tin Plate Co. 350
American Telephone & Telegraph Co. 330
Auto Accessory Manufacturer 356

Banca Lopez Quesada 344
W. F. & John Barnes Co. 356
Harold M. Bennett 348
Bernard & Heller 347
Louis Bossert & Sons, Inc. 348
Box 43 357
Box 160 353
Bradley Polytechnic Institute 344
Bridgman & Edey 348
Broderick & Bascom Rope Co. 342
Buckeye Prima Co. 347

Cadmus Products Co. 347
Chicago School of Watchmaking 356
Chicago Stock Gear Works 356
P. F. Collier & Son Co. 353
Concrete Surfacing Machinery Co. 342
F. H. Cross 353
A. B. Curry 357
Cyclone Fence Co. 334

Dayton Steel Foundry Co. 347
C. S. Demaree 357
Dictograph Products Corp. 356
Dodd, Mead & Co. 355
F. J. Drake & Co. 342

Federal Motor Truck Co. 292
Firestone Tire & Rubber Co. 346
Florsheim Shoe Co. 349
Foley Saw Tool Company 347

General Electric Co. 290
General Motors Corp. 333, 359
General Motors Truck Co. 332, 358
General Radio Co. 350
Gerold Co. 344
Godfrey Conveyor Co. 336
B. F. Goodrich Rubber Co. 360
Gurney Ball Bearing Co. 360

Harper & Brothers 339-347
Hotel Empire 354
Hotel Fort Shelby 353
Hotel Mayflower 350
International Correspondence Schools 356

W. A. Jones Foundry & Machine Co. 340

Kellogg Switchboard & Supply Co. 350

Lewis-Shepard Co. 345
Liggett & Myers Tobacco Co. 354
Lorraine Hotel 347

Manufacturer 347
Arthur May & Co. 348
Modelmaker 347
W. & D. Mogey 357
H. E. McElwain 357
McKinney, Marsh & Cushing, Inc. 349
Moore & Co. 357
More Handy Truck Corp. 347

Munn & Co. 336-354
National Carbon Co., Inc. 351
Northern Hard Maple Mfrs. 337

Old Fisherman's Calendar 357
Otis Engineering Co. 357
W. Ottway & Co., Ltd. 354

Racine Tool & Machine Co. 357
Radio Corporation of America 329
Review of Reviews 346
RUV Co., Inc. 357

Schwerdtle Stamp Co. 347
Scientific Apparatus Corp. 340
Scientific Detective Laboratories 357
Simonds Saw & Steel Co. 344
Mr. Sinclair 356
Skayef Ball Bearing Co. 289
Smith Gas Engineering Co. 343
Smith Typewriter Sales Co. 347
South Bend Bait Co. 344
South Bend Lathe Works 356
Starrett Mfg. Co. 350
Stephenson Laboratory 347
Stewart Iron Works Co., Inc. 350

Taylor Instrument Companies 345
Timken Roller Bearing Co. ..... Back Cover

Unisol Mfg. Co. 350
United States Gypsum Co. 339
Universal Motor Co. 356

Veeder Mfg. Co. 349
Vilter Mfg. Co. 342

Weller Mfg. Co. 344
Westinghouse Electric & Mfg. Co., ... Inside Back Cover
Weyerhaeuser Forest Products 331
Willys-Overland, Inc. ..... Inside Front Cover
Wisconsin Electric Co. 357
Wisconsin Motor Mfg. Co. 341

Henry Zuhr, Inc. 357

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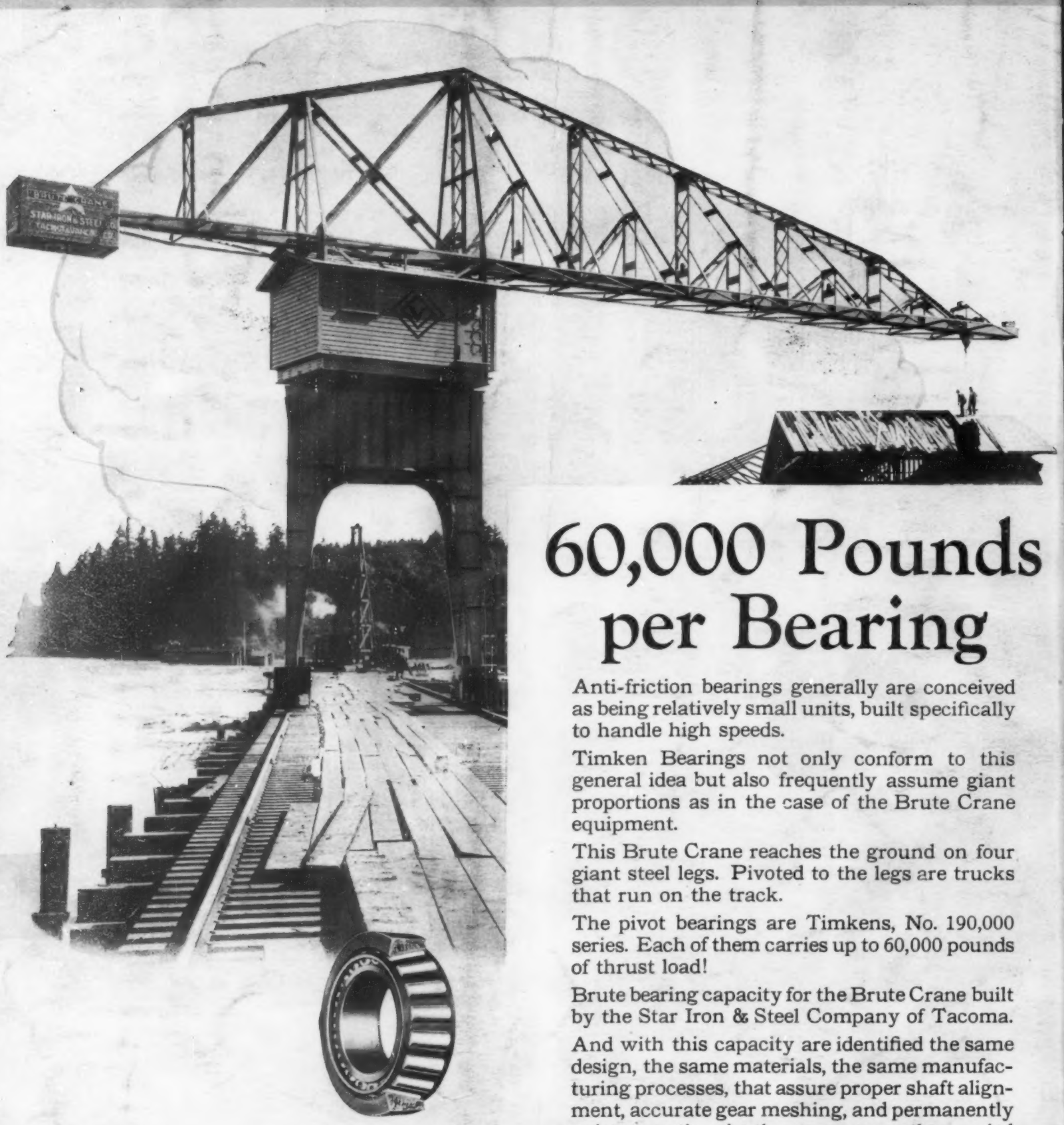

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